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Working life of water and environmental engineers: a case study of career paths, core competencies and the role of sustainable development

Master's thesis for the degree of Master of Science (Technology) submitted for inspection.

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Tiivistelmä
Tämä opinnäytetyö käsittelee vesi- ja ympäristötekniikan diplomi-insinöörien alku-uran kehitystä, siinä tarvittavia keskeisimpiä taitoja ja kestävän kehityksen roolia alan opetuksessa ja työelämässä. Tutkimus toteutettiin Aalto yliopiston uuden Vesi- ja ympäristötekniikan maisteriohjelman kehittämiseksi ja etenkin sen ajankohtaisuuden ja työelämärelevanssin varmistamiseksi. Aineisto kerättiin Aallon vesi- ja ympäristötekniikan koulutusohjelmista vuosina 2007-2016 valmistuneille lähetetyllä verkkokyselyllä ja sitä täydentävillä teemahaastatteluilla.

Tämän tapaustutkimuksen mukaan vesi- ja ympäristötekniikan diplomi-insinöörien työtilanne on Suomessa tasaisen varma, ja heidän osaamistaan tarvitaan usealla työelämäsektorilla ja monenlaisissa tehtävissä. Samaan aikaan työelämä monimutkaisine tehtävineen ja uusine haasteineen vaatii laaja-alaista osaamista. Perinteisten insinööritaitojen, kuten ongelmanratkaisun lisäksi, tarvitaan myös ajanhallinta- ja priorisointi-, sekä vuorovaikutustaitoja. Insinöörien pitää olla itseohjautuvia ja oma-aloitteisia, seurata oman alan kehitystä ja oppia uutta, sekä pystyä ottamaan vastuuta ja tehdä päätöksiä.

Aalto yliopiston tavoitteena on integroida vastuullisuus ja kestävä kehitys kaikkeen opetukseen, ja olla sitä kautta rakentamassa kestävyydelle perustuvaa innovaatioyhteiskuntaa. Tutkimuksen mukaan useilla alku-urallaan olevilla vesi- ja ympäristötekniikan diplomi-insinööreillä on kuitenkin puutteelliset tiedot kestävästä kehityksestä, mikä vaikeuttaa heidän kykyään yhdistää kestävän kehityksen periaatteita omiin työtehtäviinsä ja toimia niiden mukaisesti. Jotkut myös suhtautuvat kestävään kehitykseen kriittisesti ja näkevät sen olevan alasta irrallaan oleva teoria, jolla ei ole juurikaan tekemistä käytännön kanssa. Suurin osa vastaajista kuitenkin ajattelee kestävän kehityksen olevan kiinteä osa alaa ja myös erittäin tärkeä yhteiskunnallinen teema. Kestävän kehityksen integroiminen insinöörikoulutukseen vaatii laajempien aihealueiden ymmärrystä ja systemaattisen ajattelun käyttöä; sama osaaminen on keskeisessä roolissa myös nykyajan työelämässä. Vesi- ja ympäristötekniikan uuden maisteriohjelman rakenne ja sisältö vastaa hyvin tähän vaatimukseen.

Kestävä kehitys mainitaan tällä hetkellä organisaatioiden strategioissa ja arvoissa, mutta se ei aina heijastu jokapäiväiseen työhön. Vesi- ja ympäristötekniikan diplomi-insinöörit voisivat laajan osaamisensa ja moninaisten yhteiskunnallisten rooliensa avulla olla etulinjassa rakentamassa kestävämpää yhteiskuntaa.

Avainsanat insinöörikoulutus, kestävä kehitys, koulutus, osaamisalueet, työelämätaidot, työllisyys, vesitekniikka, ympäristötekniikka

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Abstract of master's thesis

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Abstract

This Thesis study covers career development, core working life competencies, and the role of sustainable development in the early careers of water and environmental engineers. The study was conducted to support the implementation and development of the new Master's Programme in Water and Environmental Engineering at Aalto University to meet the requirements of working life. Data was collected using an online questionnaire that was sent to engineers who have graduated during the past ten years (2007-2016), and complementary semi-structured theme interviews.

According to this case study, water and environmental engineers in Finland have safe employment situation, and their expertise is required in several societal sectors and in various duties. Modern working life with complex tasks and new challenges demand for a wide array of skills and knowledge. In addition to traditional engineering skills such as problem solving, present work life requires also time-management and prioritization skills, as well as people skills. Furthermore, engineers need to be able to take initiative and be self-directional, be up-to-date by actively searching for information and learning, and be able to make decision and taking responsibility.

The aim of the Aalto University is to integrate responsibility and sustainable development into all teaching, and to build a sustainable society driven by innovation. According to this study, several early-career engineers working in the field have deficient knowledge of sustainable development, which hampers their capability to connect their job with the sustainable development concept and to act according to the sustainability principles. Some are also presenting criticism towards sustainable development and see it as a separate theory with little application to engineering work. Majority nonetheless see it being built-in in the field and also an essential societal theme. Integrating sustainable development into engineering education requires understanding of wider concept and using systemic thinking. The same competencies are also central in the modern working life. The structure and the content of the new Master's Programme is responding to this demand.

At the moment, developing sustainable world is mentioned in strategies and visions of organizations, but it is not reflected fully in everyday tasks. Water and environmental engineers with their wide set of competencies and variety of roles in the society could be in the vanguard of progress in building a more sustainable society.

Keywords education, employment, engineering education, environmental engineering, knowledge, sustainable development, water engineering, working life skills

Alkusanat

Ympäri mennään ja yhteen tullaan! Kirjoitin portfolioni ensimmäisessä versiossa syksyllä 2016, että elinikäinen oppiminen ja joustavuus saivat planktonekologin tulemaan Aalto yliopistoon opiskelemaan vesi- ja ympäristötekniikkaa. Kukapa olisi uskonut, että puolitoista vuotta myöhemmin olen kirjoittanut diplomityöhöni näiden asioiden merkityksestä alan diplomi-insinöörien uralla ja työelämässä. Kuten minäkin, myös moni heistä on kulkenut urapolullaan mieli avoimena vastaan tulleisiin mahdollisuuksiin tarttuen. Toivon uuden tutkinnon avaavan uusia mielenkiintoisia urasuuntia. Paatuneen luonnontieteilijän aivoja yhteiskunnallisten asioiden pohtiminen on ainakin tuulettanut.

Tämä opinnäytetyö on tehty osana Aallon Vesi- ja ympäristötekniikan maisteriohjelman kehittämisprojektia. Projektin rahoittajana toimii Maa- ja Vesitekniikan Tuki ry. Työn ohjaajia ovat maisteriohjelman koordinaattorit, tohtorikoulutettava Meeri Karvinen ja vanhempi yliopiston lehtori Marko Keskinen, ja valvoja professori Riku Vahala. He kaikki ansaitsevat suuret kiitokset tuestaan työn eri vaiheissa, hyvin hyödyllisistä kommenteistaan ja rakentavasta palautteestaan. Kiitokset ansaitsevat myös muut vesi- ja ympäristötekniikan tutkimusryhmän jäsenet, jotka auttoivat alumnien yhteystietojen metsästyksessä. Tämän tutkimuksen tekeminen ei olisi onnistunut ilman innokkaita alumneja, jotka näkivät aikaa ja vaivaa vastatessaan kyselyyn, sekä erityisesti neljää haastateltavaa, jotka jaksoivat avata näkemyksiään alan tilasta ja tulevaisuudesta. Suuri kiitos heille! Lopuksi haluan kiittää opiskelijakollegaani Maijaa eteenpäin puskevasta vertaistuesta, sekä tietenkin puolisoani Jarkkoa ihan kaikesta.

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Anu Vehmaa

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1 Introduction

Working life has changed in an unprecedented rate during the past couple of decades. The shift from industrial economy to office economy and information society has modified job characteristics, and there are still more changes to come (Zehr 1998; Davies et al. 2011). Where the march of technology has been the driver for the past and also for the future changes, increasing life spans, new multimedia and social media environment, and increasing global interconnectivity will also reshape the upcoming work life (Davies et al. 2011). Modern working life with more complex professional challenges requires variety of skills that were not on demand list still a generation ago. Skills for the future work force could for example be social intelligence, new-media literacy, transdisciplinarity, design mindset, and cognitive load management (Davies et al. 2011).

The skills needed in working life are often divided into traditional technical skills, i.e. hard skills, and soft skills that are a combination of social and interpersonal skills, personal qualities and career attributes (Robles 2012 and references therein; Levasseur 2013). Historically, hard skills have been the necessity for employment. Today, personal skills such as self-awareness, interpersonal skills such as communication, group skills such as collaboration, and organizational skills such as leadership are becoming more and more critical for successful career (Levasseur 2013; Stawiski et al. 2017). There is a wide consensus on the importance of soft skills in the working life worldwide in scientific literature (e.g., Deans et al. 1999; Baytiyeh 2012; Oladokun et al. 2017; Rajadurai et al. 2017).

The modern working life requirements set challenges for educational systems. The mismatch between the skills of the graduates and expectations of the employees are especially wide in case of soft skills, however there are also shortcomings in the hard skills (Abdullah et al. 2012; Baytiyeh 2012). Particularly in developing countries, focus of education is still in teaching content instead of development of skills and competencies (Baytiyeh 2016). It is evident that teaching methods need to be modified and new methods developed in order to ensure that education will respond to the needs of the labor market (Stawiski et al. 2017).

Simultaneously, human activities are threatening the stability of the Earth systems (Rockström et al. 2009). Climate change, loss of biodiversity and other global problems urge for new methods and habits in order to preserve the life as we know it on the planet. Education is needed for people to understand the causes of their actions on future generations and to work towards a more sustainable world (UNESCO 2018). Education for sustainable development aims at promoting core competencies, such as critical and systemic thinking, collaborative decision-making, and taking responsibility for present and future generations. Incorporation of sustainable development into higher education practice is widely acknowledged (Gough & Scott 2007). There is a consensus that it should be included in the education of all disciplines, not just economics, environmental science, sociology or politics, because sustainable development occurs at the intersection of several disciplines.

Aalto University is a multidisciplinary university, which was founded in 2010 when Helsinki University of Technology, the Helsinki School of Economics and the University of Art and Design Helsinki were merged. The university is commitment to shaping the future by identifying and solving great societal challenges, and through innovation development. In the strategy for 2016-2020, the university highlights, among other things, societal impact by

mentioning *Educating game changers* as its educational objective (Aalto University 2016). One of the education related development actions is improving working life capacities of the students by strengthening the connection with industry. Furthermore, Aalto University aims at integrating responsibility and sustainable development into all teaching and learning (Aalto University 2017). All the study programs are obligated to include learning objectives that are connected to sustainability. In addition, there are several study programs that are dedicated to focus on sustainability.

The Master's Programme in Water and Environmental Engineering is one the Aalto University Master's programs that have a strong focus on sustainable development. It was launched in the fall 2016 at the same time with other new Master's programs in the Aalto School of Engineering. The motivation for the new programs is the Bologna process (European Commission 2015), which creates Europe-wide compatible two-stepped degree system. This means that the students can have more various backgrounds than the former engineering Master's students. The program combines strong technical competences with understanding of wider societal context (Aalto University 2017b). In comparison to earlier education in the field, its courses emphasize more general engineering skills such as interaction and team work skills, problem solving, and comprehensive thinking, and provide also competencies in professional identity (Karvinen, Vehmaa, Keskinen in review). Progress in the studies as well as the transition from studies to working life is supported with the Personal Development Portfolio process, which helps the student to identify their strengths, interests and targets (Keskinen 2016).

This thesis work is an explorative case study of early-career water and environmental engineers in Finland. The study was conducted in a research project related to development of the Master's Programme in Water and Environmental Engineering. In order to fulfill the needs of the modern working life and the objective of the Aalto University to educate professionals who are able to make a difference in the society, it is necessary to examine the current situation of the Aalto alumni, engineers working in the field of water and environmental engineering. The engineers who have graduated during the past ten years are still able to remember the contents of their studies and can therefore reflect them from the perspective of the working life. Their career development, satisfaction over their studies and career success and perspectives of sustainability in the field and wider in the society gives valuable information on the direction to which the education should be developed.

The aim of this thesis study is to map the early careers of water and environmental engineers, gain information on the working life skills and knowledge areas that are considered to be important in the field, and to study the role of sustainable development in it. The results will benefit the Aalto University and the Master's Programme in Water and Environmental Engineering in developing the curriculum that meets the needs of the working life. The results will give information how widely the sustainable development concept is incorporated into the field of water and environmental engineering in Finland, and what is the role of the Aalto graduates in building a more sustainable society.

The research questions that this thesis aims to answer are:

- How are the early careers of Finnish water and environmental engineers formed and in what kind of positions they are situated?
- What kind of working life skills and knowledge water and environmental engineers consider important?

- How do water and environmental engineers see the role of sustainable development in their field, are their jobs connected to it, and are they able to influence sustainable development practices and culture in their jobs?

2 Theory

2.1 Introduction to the theoretical framework

Aims of this thesis are wide-ranging; therefore, it combines and makes use of several theories. The order of this section is chronological, and it starts from the critical step in the lives of engineering graduates, employment. In the second sub-section, working life competencies are covered from the perspective of soft skills / hard skills and by giving a special emphasis on the soft skills that are expected to be important in the future. The third sub-section reviews theories that can be used to explain career development and job performance. Finally, sustainable development concept and its connection to civil engineering, and more specifically to water and environmental engineering are introduced.

2.2 Finding a job and starting a career

Engineering degrees are traditionally highly respected. The graduates have high employment rates (Batiyeh & Naja 2012; Finna & Erdei 2015). In Finland, almost 70% of the students who graduated from Finnish universities of technology in 2016 had a work contract or knew where they would work after graduation (Piri 2017) and only 1% of the engineering graduates who graduated from Aalto University in 2011 have been mostly unemployed during the first five years after graduation (Sainio et al. 2017).

High employment rate does not however tell the whole truth about the work situation of the graduates, if their jobs do not measure up with the contents of their degrees. Quality of employment in terms of correspondence to education level is proposed to be included as a funding criterion in the funding models for universities and universities of applied sciences in Finland (Ministry of Education and Culture 2017). The aim of this reform is to increase the relevance of education for the working life, and thus promote the employment of higher education graduates. The new funding model for higher education is intended to be introduced in 2019. Quality of employment has already been estimated in a career follow-up study. Five years after graduation, 53% Finnish Masters say that they utilize their education constantly in their job (Sainio et al. 2017). For engineering Masters, the proportion is slightly lower, however engineering graduates find employment that matches their education better than Finnish Masters on average. Overall, 70% of the graduates with a Master's degree have a job that corresponds well with the education (Sainio et al. 2017). Naturally, possibility to utilize education in work and to have a job that corresponds to the education is reflected in satisfaction over the career choice.

The transition from university to work life is a critical step for graduates. Success in studies does not automatically lead to success in work life, where academic knowledge and gained vocational skills are applied. Graduates do not only need to find a job to become productive professionals, they are also confronted with realities, such as sustained full-time work, administrative tasks and job security (Hettich 2000; Batiyeh & Naja 2012). Graduates might be unaware of the differences between education and corporate settings (Hettich 2000). They have chosen the field of subject for various reasons, such as prestigious reputation, personal interest, aptitude for the subject, competitive salary, or because of parent's influence (Batiyeh & Naja 2010; 2012). During the transition to working life, these images are weighed, and the graduates must meet the challenges associated with the job but also to face the possible disappointments of the unmet expectations (Batiyeh & Naja 2012).

When starting a career, a young engineering graduate faces challenges before entering the core of the work community (Batiyeh & Naja 2012). Communication is the first challenge. In multi-cultural environment cross-cultural communication skills are essential (Gilleard & Gilleard 2002), however even without language barriers work life communication skills can be challenging especially if they have not been touched upon in education (Batiyeh & Naja 2012). The next challenges are responsibility and self-confidence. In a competitive work environment, engineers are expected to be willing to take responsibility, and to be confident and motivated to keep up with the latest advancements in the field.

2.3 Working life skills and knowledge areas

To become successful in the field of engineering, one must have variety of competencies. The need to include also non-technical skills in engineering curricula has been recognized already for a couple of decades (ASEE 1994). The education programs have, however, been slow to respond to the need. Still in many countries, engineering education does not contain at all or contains very little practicing of the so-called soft skills (Gilleard & Gilleard 2002; Male 2010; Stawiski et al 2017). This can have detrimental effects on the employment and especially career development of the young graduates. As Russell and Yao (1996) appositely remark, an engineer is hired for her or his technical skills, fired for poor people skills, and promoted for leadership and management skills. Even 75% of job success might depend on soft skills and only 25% on hard skills and technical knowledge (Robless 2012 and references therein).

In their systematic review, Passow and Passow (2017) identified 16 generic engineering competencies that are important across disciplines and practice areas. They divide the competencies into four categories: applying technical foundations, collaborating with different stakeholders, engineering within constraints, and managing own performance. Of these four categories, only the first one contains purely hard skills, such as applying skills and knowledge, interpreting data, and measuring accurately. The third one contains both soft skills and hard skills, for example designing solutions, gathering information, solving problems, and making decisions. The second and the fourth one contain purely soft skills, such as communication and coordination, and taking responsibility and expanding skills, respectively.

Turner et al. (2005) made a survey to several information system stakeholders to form a general view of importance of academic and useful adjunct variables that makeup professional assemblage of information system professionals. The stakeholder groups studied were engineering students, academics, practitioners, and managers and decision makers. All the stakeholders gave high value for soft skills. Students and decision makers valued also vocational skills and other skills taught in the university, whereas academics estimated only vocational skills (the skills that they teach) and practitioners only other skills important.

Sustainability Skills (CISL 2005), Future Work Skills 2020 (Davies et al. 2011) and 21st Century Skills (Partnership for Twenty-First-Century Learning 2016) are terms that are often used for soft skills considered to be of special importance in the future. There are a lot of similarities in these terms (Table 1). Perhaps the biggest differences in these three future work skills terms are sense-making, computational thinking, and cognitive load management that are included in the Future Work Skills 2020 (Davies et al. 2011). These skills are connected to drivers that reflect advances in technology, such as rise of smart machines and

systems, and computational world. These technologies are expected to reshape the nature of work on nearly every industry over the coming decades (Anthes 2017).

Table 1 Sustainability Skills (CISL 2005), Future Work Skills 2020 (Davies et al. 2011) and 21st Century Skills (Partnership for Twenty-First-Century Learning 2016) categorized in three classes.

	Learning & Innovation Skills	**Information, Media & Technology skills**	**Life & Career skills**
21st Century Skills	creativity & innovation critical thinking & problem solving communication & collaboration	information, media, & ICT literacy	flexibility & adaptability initiative & self-direction social & cross-cultural skills productivity & accountability leadership & responsibility
Future Work Skills 2020	sense-making novel & adaptive thinking design mindset cognitive load management	computational thinking new-media literacy virtual collaboration	social intelligence cross-cultural competency transdiciplinarity
Sustainability Skills	problem solving		leadership teamwork negotiation flexibility ability to maintain an exploratory attitude

Most of the soft skills for future are mentioned also in literature concerning engineering. Leadership skills are one of the skills expected from 21st century engineers (Stawiski et al. 2017). Engineers must also be capable of leading multidisciplinary teams, combine technical and business knowledge, and to have willingness for lifelong learning (Farr & Brazil 2009). Accomplished leaders should master change, be able to take risks, have missions that matters, be able to make decisions, and use power wisely. They should also be big thinkers, team builders, good communicators, as well as ethical and courageous (Farr & Brazil 2009). High level of ethical standards is important for engineers in all positions. The role as technical experts on behalf of the society comes with large responsibilities (Starrett 2017). Required leadership skills develop from technical/entry level positions to mid-management level and further to CEO senior executive level. Importance of production/quality skills decreases and management and leadership skills increases from lower level position to higher up in the hierarchy (Farr & Brazil 2009).

In a study conducted to evaluate performance of architects and engineers and the skills needed for good performance, Ling (2002) identified enthusiasm in tackling difficult assignments, speed in producing design drawings, and problem-solving ability and project approach to be the skills that explain job performance. Together these three attributes explained 86% of the performance of evaluated architects and engineers (Ling 2002). Enthusiasm in tackling difficult assignments was interpreted to reflect persistence, whereas

speed in producing design drawings was correlated with good knowledge of constructability and regulations. The speed was thus interpreted to reflect overall task performance. Problem solving ability and project approach are important for project success (Ling 2002). Problem solving correlates also with other variables, such as creativity and innovativeness, good job knowledge and task proficiency, controllability and loyalty. According to Ling (2002), it even correlates with social skills and initiative.

Cross-cultural communication skills are also seen as a crucial skill in modern, multidisciplinary and multinational work communities (Gilleard & Gilleard 2002; Davies et al. 2011). When engineering education is given with a second language, language skills of both students and teachers are of crucial importance. Gilleard and Gilleard (2002) highlight the importance of communications skills but also ability to take into account cultural backgrounds, values and beliefs, which might set barriers for mutual understanding. According to them, these skills should be integrated to the engineering education, and they would be of great benefit for the students when they enter work life.

Although technical people are often criticized about their lack of soft skills, the skills can fortunately be practiced. If behavior is considered to be interaction of a person with environment, soft skills can be developed by exposing the person to environments where the skills are needed, i.e., to complex social surroundings (Levasseur 2013). However, development of soft skills is more difficult than development of hard skills. It requires motivation to learn but it also requires interaction with other people, willingness to reflect one's behavior, willingness to receive feedback about the behavior, and willingness to make changes to it (Levasseur 2013). Some of the soft skills, like leadership, can be taught in formal education, however most of the skill development need to be integrated into the education, and also relevance of mentorship and on the job training as well as self-actualization are highlighted (Farr & Brazil 2009).

2.4 Theoretical framework for career development and job performance

Several theories have been created to offer a set of principles and concepts for career guidance communication. Five of them are theories that are most commonly used (Leung 2008). These theories include Theory of Work Adjustment, Holland's Theory of Vocational Personalities in Work Environment, Self-concept Theory of Career Development, Gottfredson's Theory of Circumscription and Compromise, and Social cognitive career theory.

Theory of Work Adjustment (Dawis 2002; 2005; Dawis & Lofquist 1984) describes the two-way interaction between the worker and the work environment. Career choice and development is seen as a continuing process where the person is adjusting to the work environment, and the adjustment happens in cycles, which are initiated by the dis-satisfaction of the worker on the work environment or dis-satisfactoriness of the work place on the worker. One of the strengths of the theory is that several associated measurable variables have been developed (Dawis 2005). These include variables measuring satisfaction, needs and values, skills and abilities, satisfactoriness, and indexes of correspondence.

Holland's Theory of Vocational Personalities in Work Environment (Holland 1985; 1997) divides people into six categories which in addition to personality also reflect person's

vocational interest: realistic (R), investigative (I), artistic (A), social (S), enterprising (E), conventional (C). A three-letter code describing person's career interest, where the first letter is person's primary interest type, the second and the third are secondary interest types. The first one plays a major role on career choice and satisfaction, and the second and the third have a smaller but significant role on career choice processes. Environment (such as jobs) can also be described by these as a combination of these six types. If is there is a good match (high congruence) between the individual and the environment, the individual is productive and satisfied. Low congruence between the person and the environments results in dissatisfaction and instability. The six personality categories are arranged in a hexagon in the order of RIACEC. The adjacent types in the hexagon have the highest similarity whereas the opposite types the lowest degree of similarity. The concept of consistency is used to describe the coherence in individual's type scores, and distance between the letters in the hexagon is its measure. Distinguishable differences between low interest types and high interest types are a sign of differentiation, which reflects readiness for career choice specification and implementation.

Self-concept Theory of Career Development (Super 1969; 1980; 1990) sees career choice and development as process of developing and implementing of person's self-concept, which is a product of various interactions among factors such as physical and mental growth, personal experiences and environment. Vocational maturity is a development characteristic, which increases with age, is multidimensional in nature, develops at different rates in different individuals, and can help in the pre-diction of occupational satisfaction, occupational success, and career success. People have several roles in their lives at the same time, both public and private. Interference, conflicts and confusion between these roles happen most often when a person cannot cope with all the demands associated with the different roles.

According to Gottfredson's Theory of Circumscription and Compromise (Gottfredson 1981; 1996; 2002; 2005) individuals are combinations of their genetic makeup and their environment. They are also active agents that can modify their environment. Career development can thus be viewed as a self-creation process where individuals search for possibilities to express their genetic characteristics within the boundaries of their environment. They also have to respond to external realities and constraints, and therefore make compromises during the career development process.

According to Social Cognitive Career Theory (Lent et al. 2002; Lent 2005), career development depends on not only genetically inherited characteristics, but also on behavior, self-efficacy, career expectations and career goals. Self-efficacy is defined as a set of beliefs that are linked to particular performance domains and activities. Self-efficacy and outcome expectations together advance career interests, which in turn help to shape career goals. People use various actions to achieve the goals, and results of these actions (either encouraging or negative) will support or revise self-efficacy and outcome-expectations, and thus career goals. However, environment may either support or set barriers to career development. If people experience the environment to be unsupportive or even intimidating, their expectations might not turn into goals, which would be worth to aspire.

In addition to the big five career theories, there are several other theories aiming to explain career development, career success and job performance. Planned Happenstance Theory (Krumboltz's theory; Mitchell et al. 1999) is a conceptual framework, which extends career counseling to include ability to maintain an exploratory attitude while encountering

unexpected events. Its goal is to assist people to generate, recognize, and incorporate chance events into their career development. The goal can be reached by developing five skills: curiosity, persistence, flexibility, optimism, and risk-taking. Curiosity helps exploring new opportunities, persistence assists to strive despite setbacks, flexibility reflects ability to change attitudes and circumstances, optimism helps to recognize opportunities, and risk-taking skill assists in taking action even if the outcome is uncertain. Through these skills, the Planned Happenstance Theory is related to concepts describing work life skills for future, such as the Sustainability Skills, the Future Work Skills and 21st Century Skills.

Sonnentag et al. (2008) summarize job performance, which can be divided into three categories: task performance, contextual performance and adaptive performance. Task performance can be evaluated by using skills, such as job knowledge, job experience, cognitive ability and task proficiency (Hunter 1983; Schmidt et al. 1986). Task performance can be divided into 1) job-specific task proficiency, 2) non-job-specific task proficiency, 3) written and oral communication proficiency, 4) supervision, in case of leadership position, and 5) management/administration (Sonnentag et al. 2008). Contextual performance can be evaluated using soft criteria, such as social skills, commitment, and initiative (Borman & Motowidlo 1993). Contextual performance can be categorized in 1) volunteering for activities beyond person's formal job requirements, 2) persistence of enthusiasm and application when needed to complete important task requirements, 3) assistance to others, 4) following rules and prescribed procedures even when it is inconvenient, 5) openly defending organizations objectives (Sonnentag et al. 2008; Borman & Motowidlo 1993). Adaptive performance is 1) handling emergencies or crisis situations, 2) handling work stress, 3) solving problems creatively, 4) dealing with uncertainties, 5) learning tasks, technologies and procedures, 6) demonstrating interpersonal, cultural, and physically oriented adaptability (Pulakos et al. 2000).

2.5 Sustainable development

The World Commission of Environment and Development (1987) famously defined sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. While this report by "Bruntland commission" established sustainable development firmly into the global agenda, it also brought challenges: the vagueness of the definition led to some confusion and created a lack of consistency in its interpretation (e.g. Lélé 1991; Mebratu 1998). Since 2005, United Nations has promoted the concept of the three pillars of sustainable development – economic development, social development and ecological protection as interdependent and mutually reinforcing components (UN 2005). In addition, targets and goals of sustainable development have been clarified by setting eight Millennium Development Goals (UN 2015a), following 17 more specific Sustainable Development Goals (SD goals) that should be reach by 2030 (UN 2015b). The SD goals claim for example zero hunger (#2), clean water and sanitation for everybody (#6), and responsible consumption and production (#12).

Civil engineering and society have an important linkage, which creates great responsibility. Many countries have their own engineering code of ethics, which gives advice how to uphold the dignity of the profession for example by being honest and impartial, and enhancing human welfare and environment (Hansson 2009; Heikkerö 2009; ASCE 2017). For example, the Swedish Association of Graduate Engineers' honorary codex says that engineers should in their profession take personal responsibility over the use of technology for the good of

people, environment and society (Hansson 2009). Thus, the code of ethics includes the idea of values that also benefit sustainable development.

The discipline of water and environmental engineering has a historical connection with public health. The connection is strong especially in the developing regions, where the lack of water, sanitation and hygiene services is still high (Mihelcic et al. 2017). The connection to sustainable development is thus obvious for water and environmental engineers working in developing countries, however it might be more obscure for engineers in countries with high coverage of water supply and sanitation services (Takala 2017). Finnish water experts view sustainable development primarily from the environmental point of view (Takala 2017). Sustainable development is seen as an intrinsic part of the field, however public good and the role of citizens is rarely connected to the matter. In general, water services experts highlight the role of technological solutions to sustainability issues. These include for example energy and material efficiency (Takala 2017).

Incorporation of sustainable development into higher education practice is widely acknowledged (Gough & Scott 2007). Surveys on university students show that sustainable development is regarded as important and positive concept; however they also reveal incomplete knowledge on the matter (Azapagic et al. 2005; Kagawa 2007). As with water services experts, also engineering students often connect sustainable development with environmental issues, and are not really interested in aspects with social or economic focus (Kagawa 2007; Shealy et al. 2016). Multidisciplinary courses organized for the students in the fields of science, technology, engineering, and mathematics could help to see perspectives outside one's own discipline (Badurdeen et al. 2014).

One issue that can hamper integration of sustainable development and sustainability into engineering education is the attitudes and beliefs of the educators. Brown et al. (2014) recognizes three different persona types of civil engineering educators in terms of their definitions of sustainability, application of sustainability within their teaching and research, and statement of perception relating practice to beliefs. The level of knowledge appeared to be consistent within the educators, but the personal beliefs and dogmatism differed. One type expresses higher levels of belief in the importance of sustainability and demonstrates higher levels of adoption of it into teaching, whereas the third type is more dogmatic. This is reflected in relative closed belief system that actively prevents the person from accepting new and novel ideas (Brown et al. 2014).

3 Material and methods

3.1 Data collection

Two methods were used for collecting the data. Semi-quantitative questionnaire was the main method to gather information on water and environmental engineers, gain information on the working life skills and knowledge areas that are considered to be important in the field, and to study the role of sustainable development in it. In addition, semi-structured theme interviews complemented the questionnaire to improve and to deepen the picture about skills and knowledge areas that are essential in the current working life, changes in the field and in the required skills and knowledge that have happened during the past years.

An online questionnaire was sent to 176 engineers, who have graduated from Aalto University 2010-2016 or from its predecessor Helsinki University of Technology in 2007-2009, and whose major have been environmental engineering, water and environmental engineering, water resources and hydraulic engineering, or water supply and sewerage engineering. The list of graduates, their major and graduation year was received from the Dean's Unit of the School of Engineering. Majors of the ones graduated in 2007-2011 are water supply and sewerage engineering, water resources and hydraulic engineering, or alternatively environmental engineering, if they have been studying in Lahti campus. The environmental engineering program was updating education and the students had already been in the working life for some time. Since 2012, the graduates have had water and environmental engineering or environmental engineering as their majors. Contact information of the graduates was collected using LinkedIn, Google and Fonecta directory. Off all the 191 graduates that had given their acceptance for their information to be released into alumni registry after graduation, 15 were not reached.

The questionnaire was sent during the time of summer holidays in 2017. To make sure that all recipients had time to read the cover letter and answer the questions, the deadline for answering was not until 1.5 months after the first invitation. During that time, the nonrespondents received two reminders. The questionnaire included 31 questions about employment, career, skills and knowledge considered important in the field, and perceptions about the role of sustainability in the field (Appendix 1). Examples and ideas for questions were taken from questionnaires made by Tekniikan Akateemiset (Piri 2016) and Finnish Association of Civil Engineers (Vieno et al. 2012). The questionnaire included both Likert scale questions and open-ended questions.

Semi-structured theme interviews were made in order to improve and to deepen the picture about skills and knowledge areas that are essential in the current working life, changes in the field and in the required skills and knowledge that have happened during the past years. The viewpoints about future developments and the role of sustainable development in the field were also asked (Appendix 2). The four interviewees were chosen to represent both public and private sectors, as well as all the three former majors (Table 2).

Table 2 Profiles of the interviewees.

Sector	Central administration	Local administration	Research institute	Private sector
Major	Environmental engineering	Water supply & sewerage engineering	Water resources & hydraulic engineering	Water supply & sewerage engineering
Job title	Senior inspector	Planning engineer	Development engineer	Project manager
Main tasks	Inspector of Water Act	Water supply & sewerage planning	Flood risk management & watercourse regulation, development, service, research, training	Sewage surveillance & planning of treatments plants
In the field since	2003	2004	2003	2001
Engineering studies	2008-2011 (Master's studies)	2002-2007	1998-2008	2000-2007
Gender	male	female	male	female

3.2 Data analysis

To help the analysis of the gathered data, knowledge areas surveyed in the questionnaire were classified into four categories: challenges, solutions, practices & tools, and other knowledge. The challenges category includes five of the nine Planetary boundaries (Rockström et al. 2009; Steffen et al. 2015): climate change, cycling of phosphorus and nitrogen, eutrophication and pollution, land-use change, and understanding significance of biodiversity. Planetary boundaries are a concept, which by using nine Earth system processes sets the safe limits for human development (Rockström et al. 2009). So far, the safe limits have been crossed for four processes including the two core boundaries, climate change and change in biosphere integrity, meaning biodiversity loss and species extinction (Steffen et al. 2015). Crossing the boundaries can have serious consequences for Earth stability and further for human well-being (Rockström et al. 2009). Furthermore, both of the core boundaries have the potential of their own to drive the Earth system to a new state (Steffen et al. 2015). The solutions category consists of theories, and practices & tools of more practical solutions to the problems. Other knowledge category includes knowledge of other fields than water and environmental engineering. Working life skills were categorized into six groups using modified classification of Chiu et al. (2016): practical skills, communication & group work skills, social skills, sustainable development skills, leadership skills, and scientific methods.

Basic quantitative methods were used to analyze the collected questionnaire data. For example, contingency tables and generalized linear models (GLM) with Gaussian or Poisson error (especially for count data) structure were used for confirming the patterns. The error structure that gave the best fit, i.e. the minimum residual deviance was chosen for each model. The Chi-square test statistics between the original and the reduced model are reported.

Conventional content analysis was used for qualitative data analysis (open-ended questions and theme interviews). In this study, the importance of working life skills is evaluated using the soft/hard skills concept and the job performance framework of Sonnentag et al. (2008): task performance, contextual performance and adaptive performance. Career development is observed using the five big career theories (Leung 2008 and references therein) and from the Planned Happenstance perspective (Mitchell et al. 1999). Reliability of the classification regarding the opinions of sustainable development theme in the Master's program was ensured with two-step approach. The classification was made data-based, according to the opinions, and afterwards it was checked that all the opinions fit to the assigned categories.

4 Results

4.1 Representativeness of the questionnaire respondents

Exactly half of the recipients answered the questionnaire. Two thirds of the respondents have studied water and environmental engineering or water resources and hydraulic engineering as their major, which were also the two most common majors of the alumni (Table 2.). Response rate was the highest among the water resources and hydraulic engineering graduates (55%) and 48% among the environmental engineering graduates, the water and environmental engineering graduates, and the water supply and sewerage engineering graduates. Overall, the respondents represent the graduates well in terms of their major (chi-square test: $X^2 = 0.10$, df = 3, p = 0.80).

Women dominate water and environmental engineering field; two thirds of the graduates are women (Table 3). Furthermore, women (55%) were slightly more conscientious to respond to the questionnaire than men (40%). The observed sex ration is anyway close enough to the expected ratio, and the respondents represent the graduates well also in terms of their gender (chi-square test: $X^2 = 1.30$, df = 1, p = 0.26).

Table 3 Water and environmental engineering graduates and the questionnaire respondents in terms of their major and gender.

Major	Number of graduates (men, women)	Contact information not found	Number of respondents (men, women)
Environmental engineering	33 (10, 23)	6	13 (3, 10)
Water & environmental engineering	69 (18, 51)	2	32 (6, 26)
Water resources & hydraulic engineering	53 (24, 29)	2	28 (11, 17)
Water supply & sewerage engineering	36 (11, 25)	5	15 (4, 11)
Total	191 (63, 128)	15 (3, 12)	88 (24, 64)

4.2 Employment and early career

Employment situation among the water and environmental engineers is good. All respondents had a contract of employment at the time of responding, they were writing their dissertation, or they were on parental leave (Fig. 1). In addition, 68% of respondents had a contract already at the time of their graduation, whereas 23% where looking for a job.

Sixty-four percent of the respondents have not been unemployed after graduation, 31% have been unemployed only once, and the rest two or three times. Gender or major has no effect on unemployment times (GLM(gaussian): gender $X^2 = 0.21$, df = 1, p = 0.48; major $X^2 = 1.38$, df = 3, p = 0.34). Over half of the respondents would choose the same study field if they would make the decision now, one quarter would possibly choose the same field, and 24% would likely change the field. The ones who would change the field complain about

restricted work possibilities and see that other fields, such as information technology would offer better work prospects. The change of field would not necessarily be very dramatic; a few would study their former minor as major because that would serve their current job better. One respondent is very satisfied with the current job but would anyway change because there are many more interesting fields and topics that would be fun to study. The respondents that would make the same study decision again justify their answers with continuing interest, ideological reasons, and also with good and diverse work possibilities. Gender or major do not seem to affect the satisfaction over the field choice (GLM(poisson): gender $X^2 = 0.021$, df = 1, p = 0.88; major $X^2 = 2.46$, df = 3, p = 0.48).

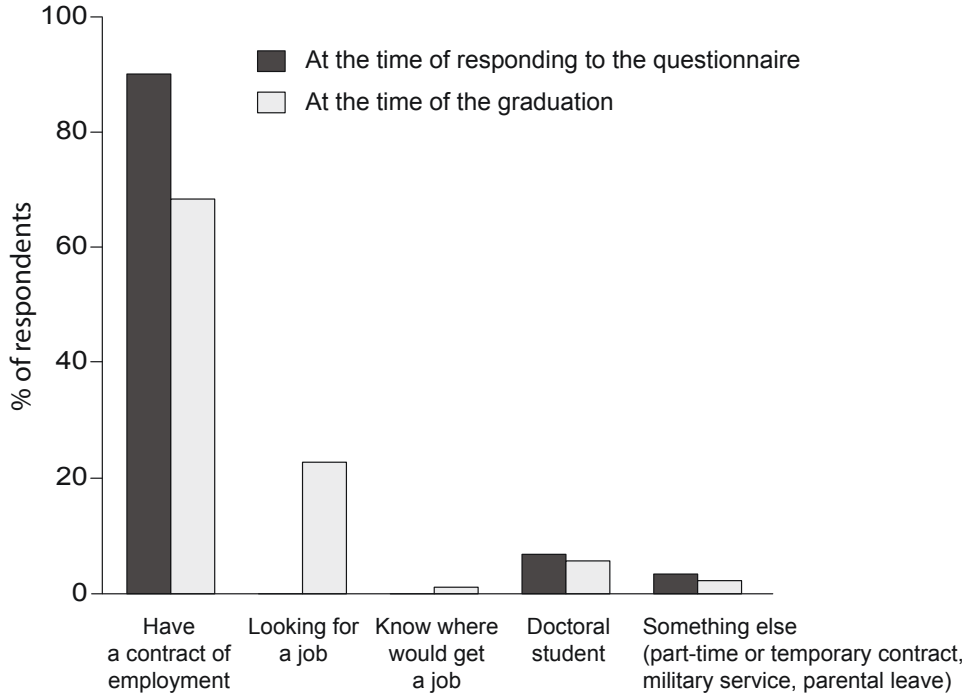


Figure 1 Employment situation of water and environmental engineers.

Water and environmental engineers find employment from several sectors, private sector being the largest employment sector for them (Fig. 2). However, there are also differences in working sectors between the majors (GLM(poisson): $X^2 = 37.86$, df = 18, p = 0.004). For example, according to this sample, universities are not a notable employer for environmental engineers and water supply and sewerage / waste management companies are not a notable employer for water resources and hydraulic engineers (Fig. 2). Almost half (45%) of the respondents are working in private sector. The largest single private employer is the international engineering consultancy, Ramboll. The second largest employers for water and environmental engineers are water supply and sewerage / waste management companies (Fig. 2), which are here separated into their own sector because their ownership varies. They can be private cooperatives, incorporated companies or public utilities owned by one or several municipalities, federations of municipalities, or units of municipalities. The largest of these employers is the Helsinki Region Environmental Services Authority HSY. Local and central administrations together provide employment for 18% of the respondents (Fig. 2). A bit more (19%) are employed by research institutes and universities. The third sector, non-profit organizations are not a notable employer for engineers of this field (Fig. 2).

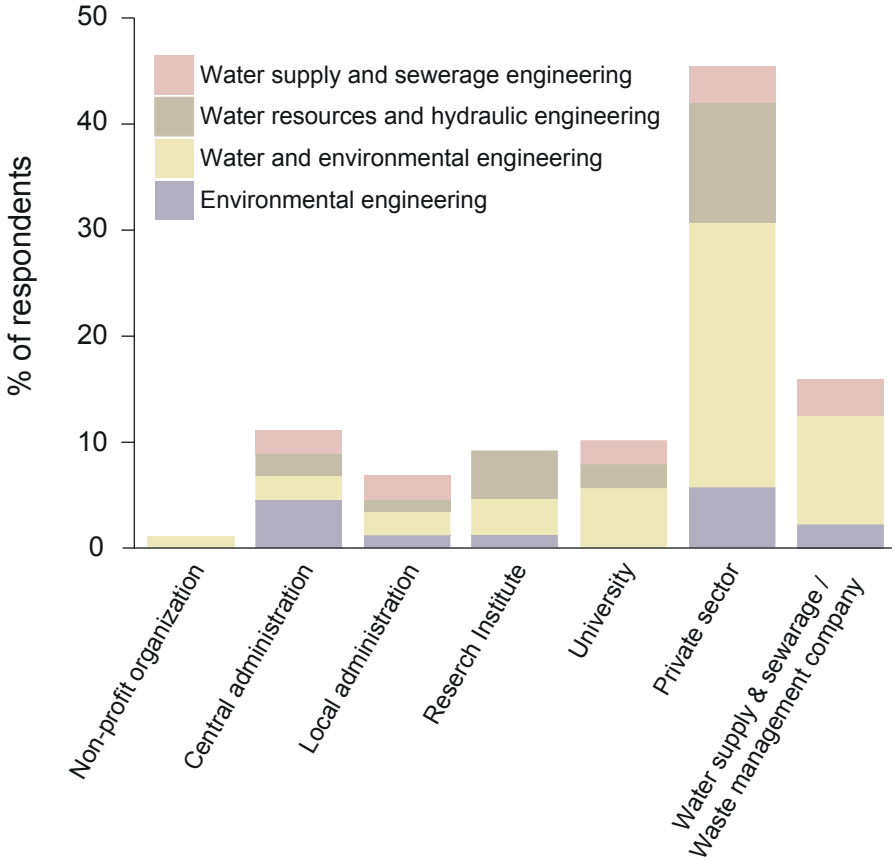


Figure 2 Work sectors for engineers with different majors in their studies. Water supply & sewerage / waste management companies are as a separate sector because they have varying ownerships, both public and private.

Overall, job contents of water and environmental engineers meet the contents of their studies. On a five-step scale (1=very poorly / not at all, 2=poorly, 3=moderately, 4=well, 5=extremely well), the median answer is 4. Three respondents have a job that meets the contents of their engineering studies very poorly or not at all. It is reasonable to say that they are employed outside the field of water and environmental engineering. Nine respondents view that their job content matches poorly with their studies. Some of them utilize their minor subject in their current job. There are also a few who have another degree, which was completed before or after the engineering studies, and which has resulted in the current employment. There seems to be some differences between the majors in how well the job content meets the contents of the studies (Fig. 3). Water supply and sewerage engineering majors have the best matching jobs, whereas the environmental engineering majors have jobs that do not meet the contents of their studies so well. The differences are not, however, statistically significant (GLM(poisson): $X^2 = 2.30$, df = 3, p = 0.513).

Water and environmental engineers start their post-graduation careers most commonly as doctoral students, experts, planners or project engineers (Fig. 4). Some also start from assistant level jobs, and a few have higher-level jobs as leaders or heads as their first jobs as qualified engineers. Expert level duties are common during the whole early career; even 10 years after graduation, 50% of the water and environmental engineers work on that level. None of the respondents were employed as CEO level jobs nor were self-employed as entrepreneurs at the time of responding to the questionnaire. Number of duties seems to

explain the career development better than time (Fig. 4). Thus, switching jobs advances career. Anyway, half of the respondents have been employed by the same employer and almost one third in the same duty during their whole career after graduation.

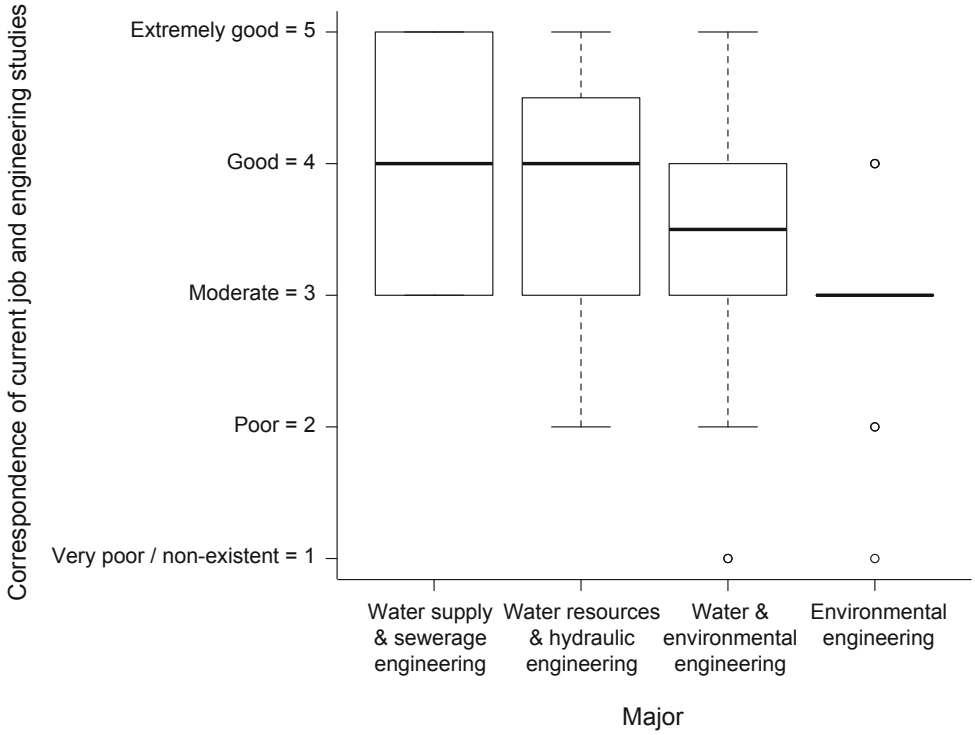


Figure 3 Correspondence of the current job and the content of the engineering studies. The boxes show the range of the upper and lower quartiles, bold horizontal bars indicate the median, the whiskers show the smallest and largest values (1.5 times the interquartile range), and the values outside this range are depicted by open circles.

Overpowering majority of the respondents tell that their careers have been formed along with opportunities without clear plans or goals (Fig. 5). One fifth say that they had clear visions how their careers should be formed at the time of graduation, however only half of them have kept those goals the same. Three respondents could not set their career into any of the given categories. Two of them did not have a clear career vision at the time of graduation and it is still missing. The first one says that the vision is now slowly forming, but the another feels that job opportunities have not made it any clearer or advanced the career. The third one ponders that he has been playing it safe and that he could have been taking more risks, however at least his income is secured. Career plans or lack of them do not seem to affect career progress, or the other way around, the level of the current job does not have an effect on how the respondents describe their careers (GLM(poisson): $X2 = 14.06$, $df = 18$, $p = 0.73$). Furthermore, gender or major do not have an effect on how career goal-oriented the person is in this sample (GLM(poisson): gender $X^2 = 4.93$, $df = 6$, $p = 0.55$; major $X^2 = 14.97$, $df = 18$, $p = 0.66$).

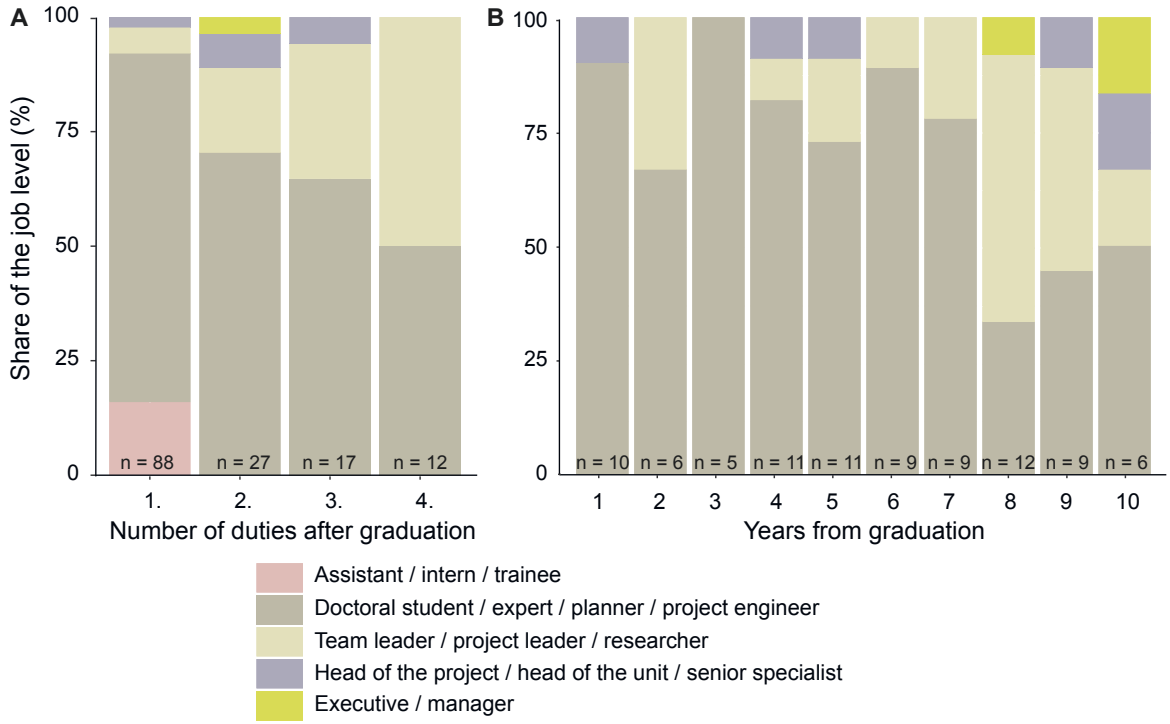


Figure 4 Level of duties in terms of a) number of duties after graduation and b) time since graduation.

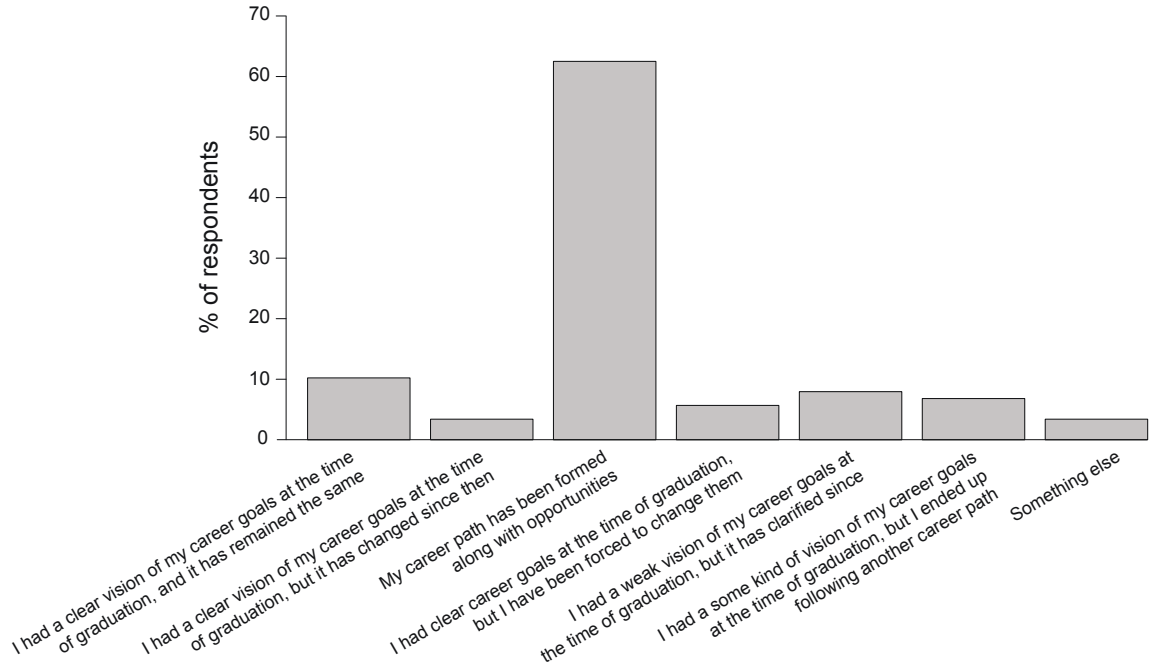


Figure 5 Distribution of career paths among the respondents.

The respondents who have had clear career goals and whose goals have stayed the same have been unemployed the least of all career path groups (Fig. 6). The median number for unemployment times is zero for all groups, but only one of the nine respondents with very clear visions of their career path has been unemployed after graduation. However, the pattern is not statistically significant (GLM(poisson): $X^2 = 1.48$, df = 6, p = 0.96).

Some patterns are revealed when career paths are plotted against satisfaction over engineering studies. The respondents were asked how well did the studies prepare them for working life. The ones who have had clear career plans and who have been able to maintain them are also the most satisfied with their studies, and the ones who have changed their visions of career goals are the least satisfied with their studies (Fig. 7a), even though the difference is not statistically significant (GLM(gaussian): $X^2 = 1.16$, df = 6, p = 0.88). The ones who are the least satisfied with their studies justify their dissatisfaction for example with the lack of basic working life skills and student counseling. In addition, they think that IT-skills were not taught enough. A few respondents tell that their earlier studies had a bigger role in preparing them for working life. Similar pattern that slightly points towards dissatisfaction over the career is seen when career paths are plotted against likelihood of choosing the same study field again (Fig 7b). However, this pattern is not significant either (GLM(poisson): $X^2 = 2.17$, df = 6, p = 0.90). Three respondents do not seem to fit into any of the career path options. They are also the ones who are the least likely to choose the same study field again. Interestingly, they are anyway moderately satisfied with the working life readiness that the studies provided.

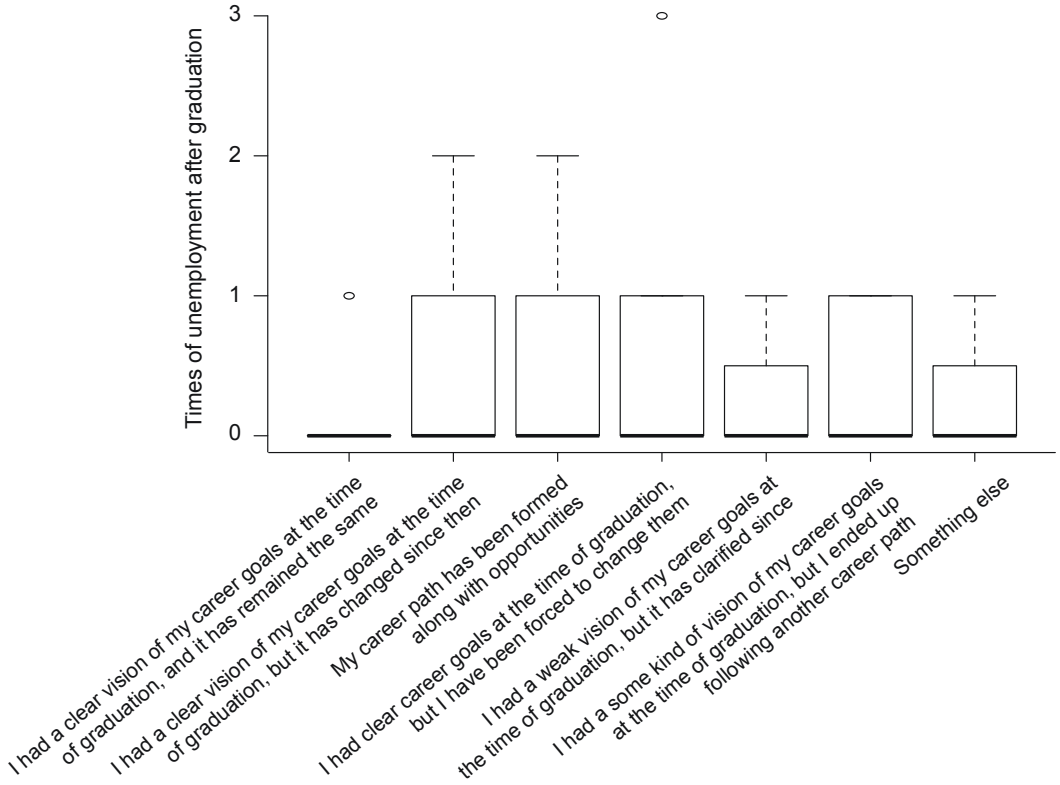


Figure 6 Career paths and times of unemployment after graduation. Interpretation as in Fig. 3.

The respondents were asked if they think that the central working life knowledge and skills, such as special skills, fields of know-how, attitudes and roles are beginning to form already during the studies. The median answer is that this is true. Although it would be reasonable to assume that the ones who are certain and confident about their careers would also have clear work roles formed already during the studies, there is no connection between career paths and the answer to the question in question (GLM(gaussian): $X^2 = 1.20$, df = 6, p = 0.98). The respondents highlight the role of working life instead of studies as the former.

Several also mention the importance of gaining work experience during the studies. One respondent says that ‘the skills are mainly formed but the knowledge particularly began to form during the studies’. Another one sees that specific skills help with the employment but the further development happens in the working life.

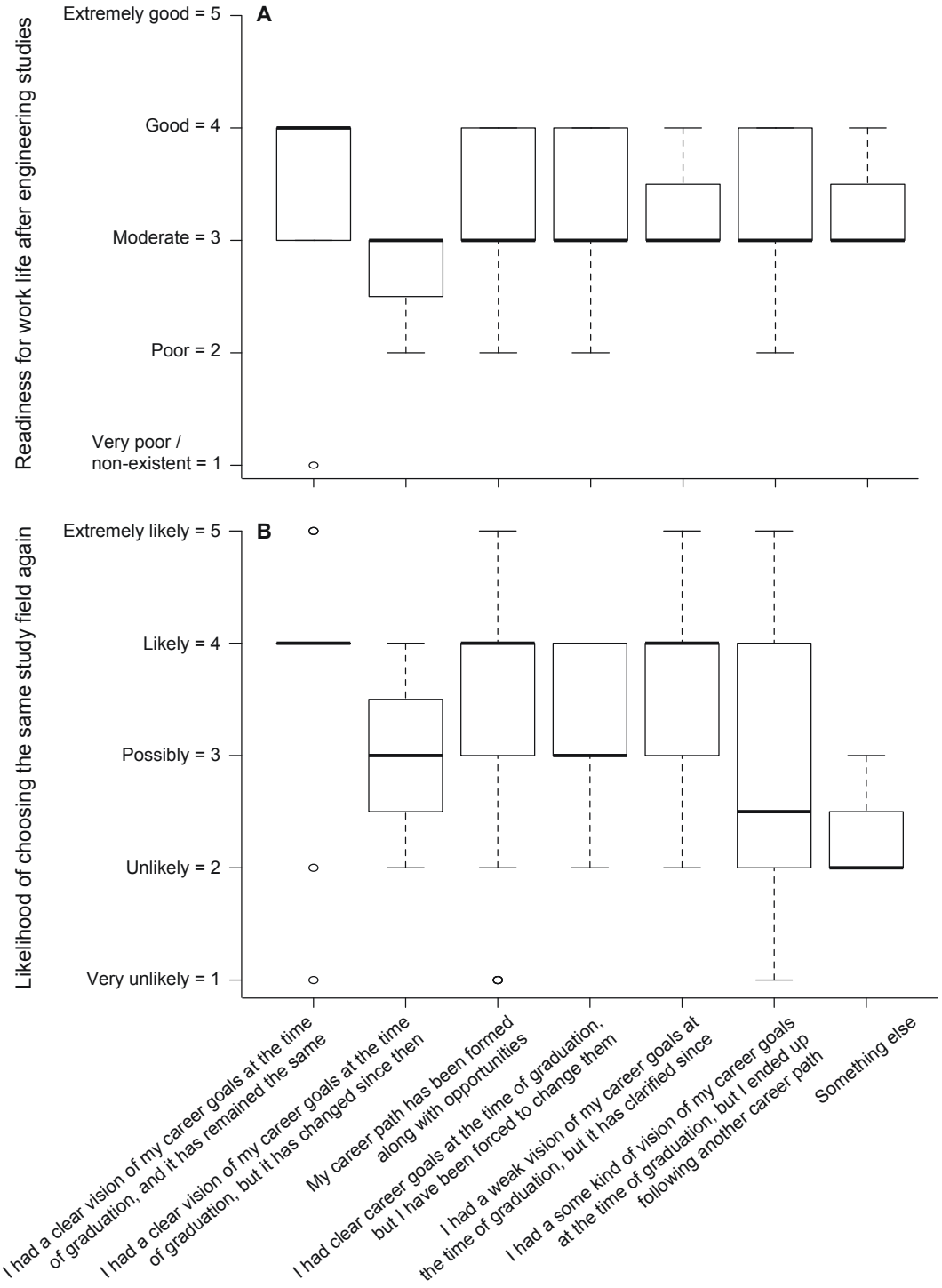
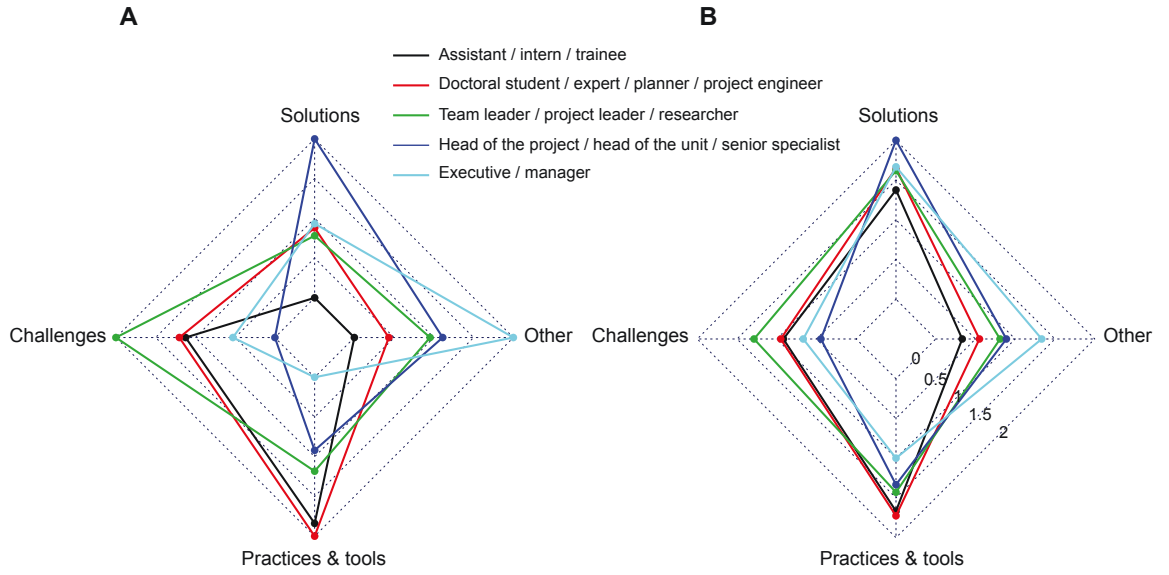


Figure 7 Career paths and a) perception over readiness for working life after engineering studies, b) likelihood of choosing the same study field all over again. Interpretation as in Fig. 3.

4.3 Important knowledge areas

The respondents were asked to choose five knowledge areas that they consider the most important for the work levels at which they have worked. The knowledge areas were classified into four categories: Challenges, Solutions, Practices and tools, and Other knowledge. Practices and tools are the most important knowledge areas for the assistant and the expert levels (Fig 8a & b), whereas solutions are the most important knowledge areas for leader, head and manager level engineers (Fig. 8b). Those two knowledge areas are the two most important areas for every level engineers, except managers are expected to master also other fields (8b). Knowledge of challenges is more important for team leader, project leader and researcher level (Fig 8a).



Solutions	Challenges	Practices & tools	Other knowledge
Circular economy & waste management	Climate change	Engineering knowledge (e.g. IT, Excel, GIS, programming)	Entrepreneurship
Governance & legislation of own field	Cycling of phosphorus & nitrogen	Hydrology & hydraulics	Knowledge of construction engineering pratices
Life cycle thinking	Eutrophication & pollution	Knowledge of environmental engineering practices	Leadership
Principles of business & economy	Global sustainable development challenges	Knowledge of water supply & sewerage practices	Knowledge of other fields (forestry, energy technology, understanding how society works)
Social responsibility	Land-use change	Risk assessment	
Theories of own field	Understanding significance of biodiversity		

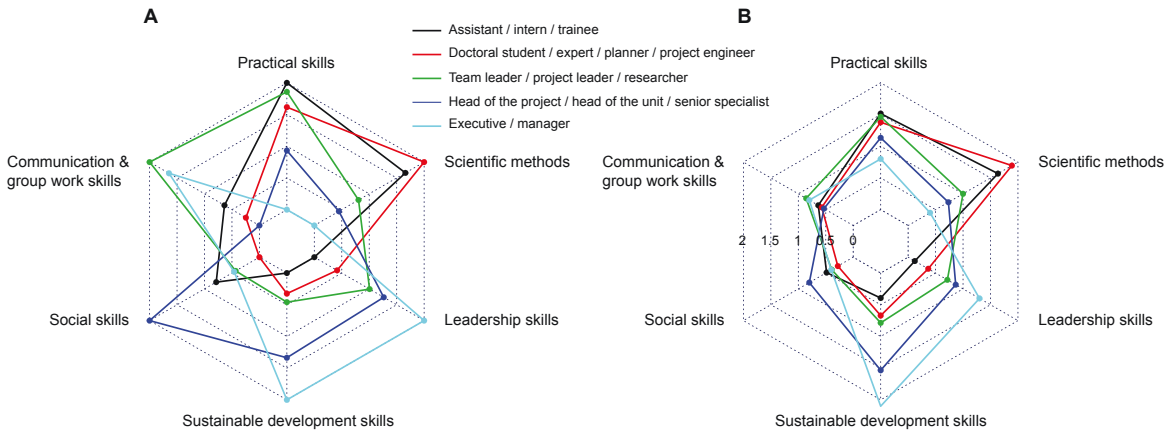
Figure 8 The most important knowledge for different work levels: a) Comparison between work levels, b) comparison between knowledge categories, showing how many times knowledge from the categories have been mentioned on average on each work level.

According to the respondents, there are four knowledge areas that stand out from the rest. The most important knowledge area for water and environmental engineers is Governance and legislation of own field. It is considered to be one of the most important knowledge areas on every job level except executives and managers. Knowledge of governance and legislation of own field is important especially for engineers working as officials at central or local administration and for those whose major in engineering studies was environmental engineering. The second important knowledge, Hydrology and hydraulics is also important on all levels except executives and managers. It is needed especially in central administration and by those who have studied water resources and hydraulic engineering as their major. Theories of own field and Knowledge of water supply and sewerage practices are important especially on assistant and expert level jobs, and they are needed especially in jobs in universities and in local administration, respectively. Leadership is considered to be the most

important knowledge for executives and managers. Knowledge areas categorized as Challenges are not considered to be top priority for water and environmental engineers. Land-use change and Climate change are the most essential knowledge from the category. Climate change knowledge is important for engineers working in universities.

4.4 Important working life skills

The respondents were also asked to choose five skills that they consider the most important for the work levels at which they have worked. The skills were divided into six categories: Practical skills, Communication and group work skills, Social skills, Sustainable development skills, Leadership skills, and Scientific methods. Scientific methods are considered to be important on the assistant and experts levels, more important for them than for any other work level (Fig 9a & b). Practical skills are the most important skills category for team leaders (Fig 9b), but in comparison to other work levels, Communication and group work skills are more important for team leaders than for anybody else (Fig 9a). Category called Sustainable development skills is the most important category for head of the project and manager level engineers (Fig. 9b). When compared to other levels, Social skills are more important for head of the project level, and leadership skills for manager level than for any other work levels (Fig 9a).



Practical skills	**Communication & group work skills**	**Social skills**	**Sustainable development skills**	**Leadership skills**	**Scientific methods**
Arrangement & coordination skills	Communication & presentation skills	Negotiation skills	Ability to make & execute changes	Leadership	Analytical & critical thinking
Initiative & self-direction	Group work skills	Social skills	Creativity & flexibility	Decision making & responsibility	Comprehension & application of theories
Time management & prioritization	Scientific writing		Ethical & value-based thinking	Teaching & supervision	Computational skills
			Future orientation & forethought		Problem solving
			Systemic, wide-ranging, connective thinking		Searching & updating information, active learning
			Transdiciplinarity, acting in multidiciplinary environments		

Figure 9 The most important skills for different work levels: a) Comparison between work levels, b) comparison between skills categories, showing how many times skills from the categories have been mentioned on average on each work level.

The single most important working life skill is Time-management and prioritization, which is considered to be one of the most important skill for all except executives and managers. The next important skills are Initiative and self-direction and Searching and updating information, active learning, which are important especially for assistants and experts. Problem solving skill is important for expert levels engineers, and Future orientation and forethought as well as Decision making and responsibility are essential skills for head of the project and manager level engineers. In addition, Communication and presentation skills and Leadership are also considered important for executives and managers.

4.5 Role of sustainable development in the field

Majority of the water and environmental engineers (64%) say that their current or former job is connected to sustainable development (Fig. 10). Engineers who have studied water resources and hydraulic engineering as their major have most often a job that is connected to sustainable development; for other majors the connection is present approximately in half of the cases (Fig. 10a). Thus, sustainable development connection of jobs is not dependent on the major (GLM(poisson): $X^2 = 2.86$, df = 3, p = 0.41). The ones who are working in private sector or in universities have more often jobs that are connected to sustainable development, whereas in water supply and sewerage / waste management companies the connection is missing in most of the cases (Fig. 10b). The differences in sustainable development connections of jobs between the sectors is not statistically significant (GLM(poisson): $X^2 = 5.65$, df = 6, p = 0.46). Furthermore, sustainable connection of jobs is not dependent on gender (GLM(poisson): $X^2 = 0.002$, df = 1, p = 0.96) or work level either (GLM(poisson): $X^2 = 2.26$, df = 3, p = 0.52).

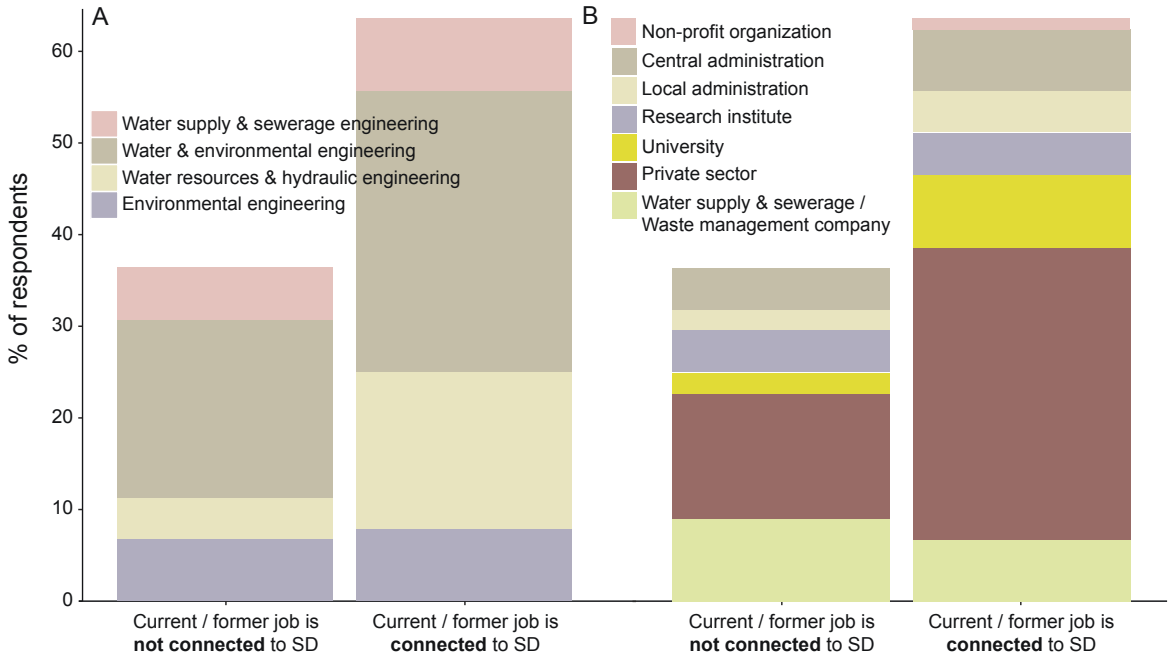


Figure 10 Sustainable development connections of current or former jobs according to water and environmental engineers a) with different majors in their studies or b) jobs in different sectors.

Environmental engineering majors are the most satisfied and water supply and sewerage engineering majors the least satisfied with the sustainable development contents of their studies (Fig 11a), however the differences are not statistically significant (GLM(poisson): $X^2 = 0.50$, df = 3, p = 0.92). The level of the current job does not influence satisfaction over sustainable development content of the studies either. The ones who are head of projects, head of units or senior researchers are the least satisfied (Fig 11b) but they are not many (GLM(poisson): $X^2 = 1.34$, df = 3, p = 0.72). Four respondents say that their studies did not offer information about how to act according to sustainable development principles in their jobs or offered information very poorly. One of them justified the answer by telling that she does not know the principles of sustainable development. Of those fourteen respondents that think that the studies offered poorly information about sustainable development, a few say

that it is difficult to find any other contact between the field and sustainable development than developmental projects, or that sustainable development was introduced as separate concept without any connection to practice. Two respondents reply that they are extremely happy with sustainable development content in their studies. Those two do not give justifications for their high grading, however the ones who are satisfied with the content write highly about the Sustainable Global Technology program or say that the theme was central in many courses.

The ones whose current or former job is connected to sustainable development are slightly more satisfied with the related study contents than the ones whose current or former job is not connected to sustainable development (Fig 12), however the difference is not significant (GLM(poisson): $X^2 = 0.16$, df = 1, p = 0.69).

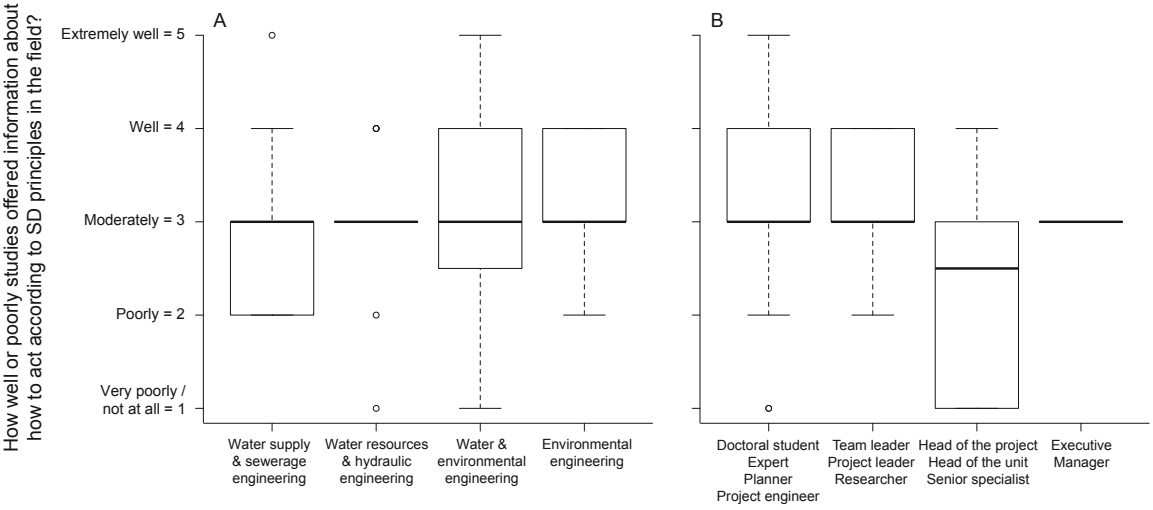


Figure 11 Satisfaction over the sustainable development content of engineering studies a) by major, and b) by the level of the current job. Interpretation as in Fig. 3.

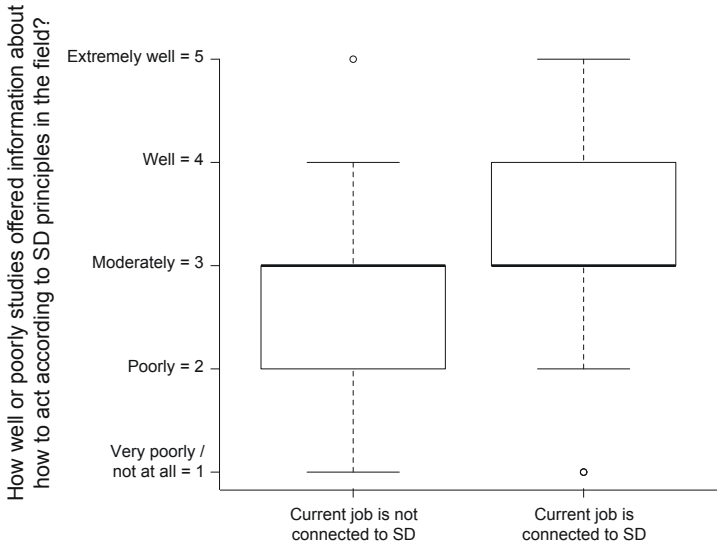


Figure 12 Satisfaction over the sustainable development content of the studies for those whose current or former job is on their opinion not connected to sustainable development

and for those whose current or former job is connected to sustainable development. Interpretation as in Fig. 3.

Water and environmental engineers feel that they have moderately power to influence sustainable development methods and culture in their current organization. Water supply and sewerage engineering majors have slightly higher perceptions of their influence over sustainable development methods and culture than graduates with other majors (Fig 13a) but the difference is not statistically significant (GLM(poisson): $X^2 = 0.88$, df = 3, p = 0.83). Even the level of the job does not have a clear effect on power over sustainability decisions; only the ones on the executive manager level can clearly influence sustainable development methods and culture of their current organization (Fig 13b) (GLM(poisson): $X^2 = 1.65$, df = 3, p = 0.65). Low influence is explained by low position in the hierarchy or with the fact that price affects more in the decision making than anything else. However, open answers reflect even more positive influencing possibilities. Respondents might have the only knowledge of sustainable development matters in the organization, they can be part of the team developing the sustainable development culture and methods, or they can take into account the sustainable development principles in planning processes.

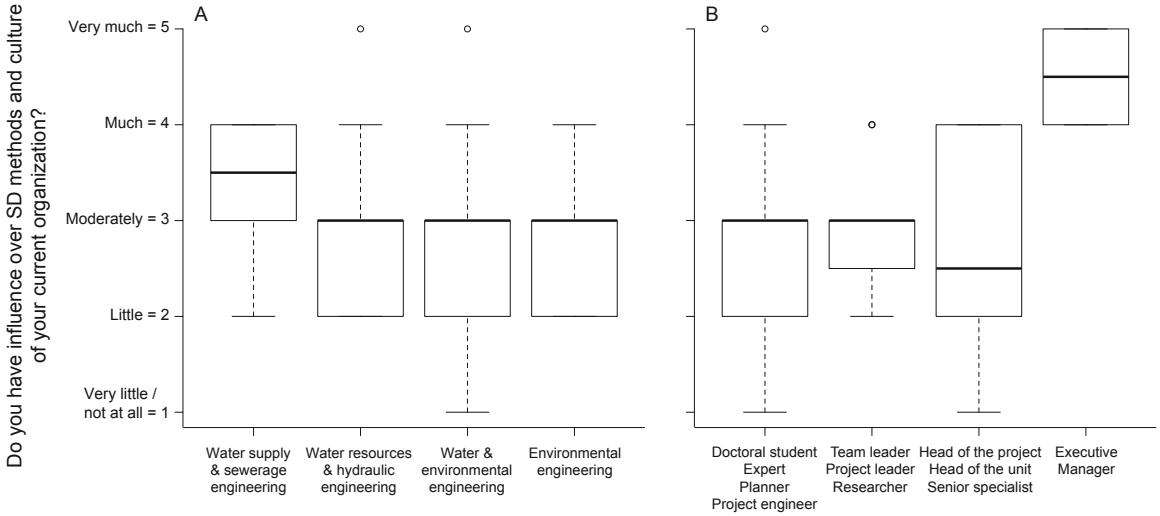


Figure 13 Influence over sustainable development methods and culture in current job organizations a) between the majors, and b) between the levels of the current job. N = 86. Two respondents could not say if they have power or not. Interpretation as in Fig. 3.

Like with the satisfaction over sustainable development content of the studies, the respondents whose former or current job is connected to sustainable development also see their influence over sustainable development methods and culture in their organization higher than the ones whose former job is not, in their opinion, connected to sustainable development (Fig 14). However, the difference in power perceptions between the two groups is not statistically significant (GLM(poisson): $X^2 = 2.46$, df = 1, p = 0.12).

Figure 14 Influence over sustainable development methods and culture in current job organization of those who see that their current or former job is not connected or is connected to sustainable development. Interpretation as in Fig. 3.

Aim of the new Master's Programme in Water and Environmental Engineering is ensuring sustainable and functional society. Sustainable development is therefore one of the central and crosscutting themes of the program. The respondents were asked perceptions over the theme and viewpoints concerning the role of sustainable development in the field. The responses vary from extremely positive to extremely negative, therefore they are classified into six categories between those extremes (Table 4). There are also a few inconsistent replies, which form their own category. Almost half of the 60 replies are extremely positive (Fig. 15). The second largest group is those who are positive but with some preconditions. Most commonly those preconditions are connected with ensuring the practice in studies. Ten percent of the respondents have a negative perception (categories 1, 2 or 3) (Fig. 15).

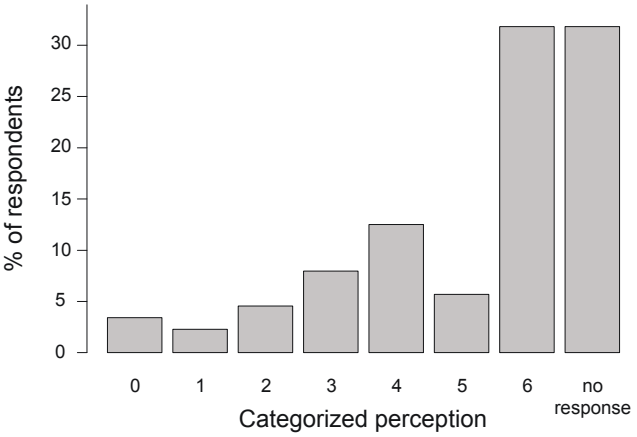


Figure 15 Distributions over perceptions of sustainable development theme in the Master's programme. Categories are explained in Table 3.

Table 4 Classified perceptions with justifications of sustainable development being the one of the central and crosscutting themes of the new Master's Programme in Water and Environmental Engineering.

0 **Inconsistent opinion**	1 **Very negative opinion**	2 **Negative opinion**	3 **Not so good idea**	4 **Positive with some preconditions**	5 **Positive opinion**	6 **Very positive opinion**
Reply contradictory	No justifications	Program should concentrate on basic technical science	Not essential for the field, decisions based on money	Must become concrete in studies / connection with practice ensured	No justifications	Relates to everything / should be considered in all actions
Aim important		Engineers should be able to calculate & solve problems	Definition vague	Definition vague		All-embracing
Connection with the field ambiguous		Interdisciplinary, takes focus from engineering towards humanities	Old-fashioned	Quite theoretical		Timely/ forward-looking
		Does not help with job search		Worn-out phrase		Essential /important
		Jargon, no connection to concrete matters				

Water supply and sewerage engineering majors have the most negative perceptions about the sustainable development theme; none of them are classified into category 6 (Fig. 16). Water resources and hydraulic engineering majors, water and environmental engineering and environmental engineering majors have very similar opinions about the theme. Same trend is seen when looking at the working sectors; the ones working in water supply and sewerage / waste management companies are the most critical towards the theme (Fig. 17). Doctoral students working in universities are the most homogeneous group. They are all have positive attitudes towards the sustainable development theme, however most of them have preconditions. Whether or not the current or former job is connected to sustainable development does not affect the perception about sustainable development being one the central themes for the Master's Programme. Furthermore, satisfaction over sustainable development content of the studies and gender do not explain the perceptions (GLM(poisson): sector $X^2 = 2.28$, df = 6, p = 0.89; SD connection of job $X^2 = 0.023$, df = 1, p = 0.87; SD content of studies $X^2 = 0.25$, df = 1, p = 0.62; gender $X^2 = 0.11$, df = 1, p = 0.74; major $X^2 = 2.18$, df = 3, p = 0.54).

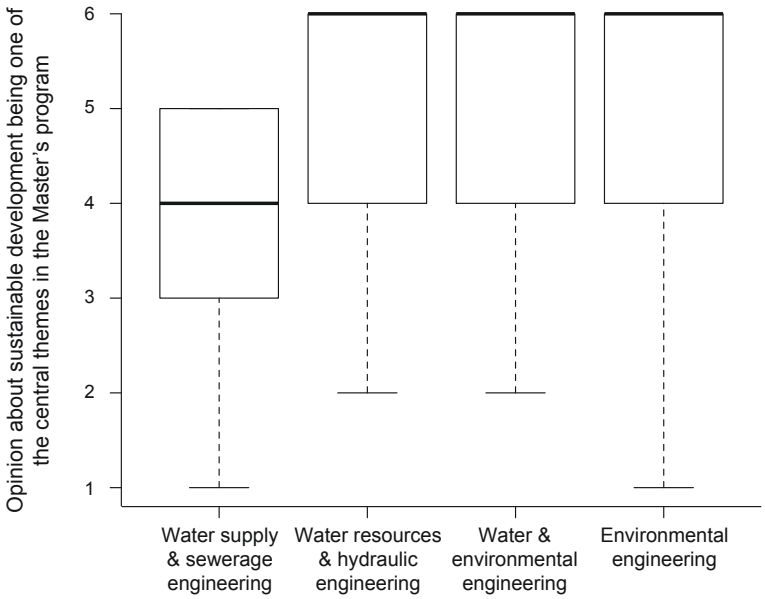


Figure 16 Perceptions of sustainable development theme of the Master's Programme in Water and Environmental Engineering. Categories as in Table 3. Interpretation as in Fig. 3.

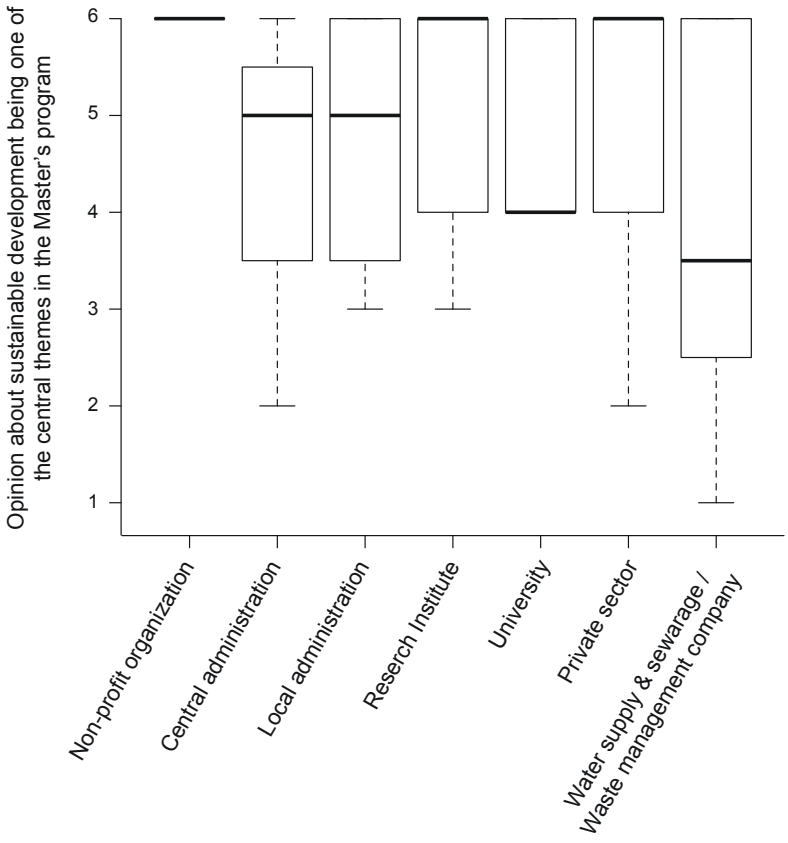


Figure 17 Perceptions of sustainable development theme by working sectors. Categories as in Table 3. Interpretation as in Fig. 3.

4.6 Interviews

All the four interviewees listed both soft skills and hard skills when they were asked about the most essential skills needed in their current job (Table 5). People skills, especially fluent and clear writing skills were mentioned by all. The officials from local and central administration emphasize the importance of comprehensible text. Even when text includes paragraphs of law, it needs to be understandable for a wide audience, from policy-makers, consultants and other officials to private citizens and concerned inhabitants. They both also make a strong argument for grammatically correct text. The interviewee working in the private sector justifies the importance of writing skills with daily writing of reports. In addition to writing skills, also other people skills as well as presentation, meeting and social skills are important for all interviewees. The questionnaire respondents evaluated problem solving as one of the most important skill for expert level engineers, however the private sector representative was the only interviewee who mentioned problem solving to be one of the essential skill in her everyday toolbox. Almost all the interviewees are doing at least some modelling, thus modelling skills and use of modelling software are essential in their current jobs. All of them have certain software that are in use daily and learning to use new software and systems has a central role in their jobs.

Table 5 Skills that are important in the current jobs of the interviewees working in different sectors. The skills are listed in the same order as they were mentioned.

Central administration	Local administration	Research institute	Private sector
Clear & fluent writing	People skills (both oral & written)	Certain software	Problem solving
Meeting skills	Fluent writing	Geospatial data & information skills	People skills
Social skills	Appearance, presentation	Some modelling	Fluent writing
ICT skills	Modelling	People skills	Software (Word, Excel, AutoCAD)
	Planning software		

Environmental legislation is important knowledge area for public officials, especially Water Act and other related laws for the central administration representative and Land-use and Building Act for the local administration representative. Emphasis of their former major is obvious in the jobs of local administration and research institute representatives. Knowledge of water supply and sewerage practices is important in the local administration job and basics of hydrology, water resources, hydraulics as well as running waters in the research institute job. The local administration representative also mentioned geospatial data and information knowledge as one of the core knowledge areas in her current job. The central administration representative benefits from basic knowledge of hydrology and biology. In addition, understanding of purely mathematical matters, such as equations and calculations, is beneficial when he needs to understand construction plans, for example, sizing of bridges. The research institute representative considers knowledge of climate change to be one of the

core knowledge area in his job. Furthermore, understanding of the sustainable development concept is essential for him as it is important to mention it in funding applications.

All the interviewees feel that requirements for their jobs have increased during their career, which can however be partly explained by the career advancement and increasing responsibility. Anyhow, three out of four claim that their work has become more hectic. The central administration and research institute representatives told that because of cuts in personnel, requirements for the remaining personnel have increased. Geospatial data and information knowledge and skills were mentioned by three interviewees when they were asked how the needed skills and knowledge and the demands for people working in the field have changed during their careers. Today, digitalized maps and registers are everyday matter, but they were not during their studies. Thus, the interviewees have been forced to learn the needed GIS skills and knowledge alongside work. The private sector representative supposes that customers have become a bit more demanding. The research institute representative mentioned the flood of information as one of the time-consuming areas in his work, thus the ability to distinguish and manage relevant information has become more and more essential skill.

The interviewee who works in local administration described her job being more complicated than it used to be. Nowadays modelling skills and knowledge are essential while previously modelling tasks were outsourced to consulting companies. In addition, she says that demand for governance knowledge has increased because basically all contracts are invited to tender. This means that the employee needs to keep up with the related systems that are changing constantly. Furthermore, decisions need to be justified carefully with articles, which has increased the need for juridical knowledge.

Unlike in local administration, in central administration some tasks have been outsourced to private sector. Field measurements and samplings are examples of outsourced tasks. Cuts in administrative personnel have increased administrative tasks. The biggest change has however, happened in customer orientation. Investments in clear language have been made. In addition, the officials need to be reachable during office hours and respond quickly to all enquiries. They cannot stay anymore in their ivory towers. Instead, they need to be visible in various forums, also in social media.

When asked about the future of their field, the interviewees predicted that the development will continue to the same direction. Budget cuts and staff reductions in public administration will continue. However, the core tasks in the central administration representative's job will stay because independent surveillance tasks cannot be outsourced. The role of private consultancy companies will, on the other hand, increase in the future. The tasks of the research institute representative will also stay the same because the demand will not go away since flood risk management is statutory. Like central administration, also research institutes will be subjected to organizational changes. Their effects are still unknown. The information explosion, the rapid increase in the production rate of new information will continue to be reflected in work in research institutes and the ability to manage it will be crucial. Importance of external funding will also increase in the future.

The interviewee working in local administration foretold perhaps the largest changes in the field. A technical change that will happen in the near future is the new planning environment, which will include 3D modelling and machine control at construction sites. Planning will take into account longer time scales than before, and also existence and conservation of small

water bodies will be taken into account in plans. Climate change and its effects on duration of rains and heaviness of downpour will be a topic for research modelling in the coming years. This information will be used in making advances in urban runoff management.

When the interviewees were asked to define sustainable development, they were all focusing on ecological development, however research institute and private sector representatives mentioned also social and economic aspects of sustainable development. The two interviewees whose major has been water supply and sewerage engineering and who are both women, emphasized future generations in their definition.

Well, it means that we act so that the future generations can also enjoy of the same things, or that we do not destroy the environment, nor… I do not know the definition by heart, but it includes also social effects and the economic effects are there too, right?

Maybe I would mostly connect it with it that we have the carbon neutral city and all, so that at least we do not leave like worse legacy than what we have now. On the contrary, that we would leave a better situation for the future generations. That we would try both in everyday life and in planning work to make such decisions that naturally decrease emissions and restrain climate change. At leave behind at least as good and preferably better environment.

The definition of the research institute representative was a bit more pessimistic. He said that as we anyway follow the terms of economic growth, we have to act so that we do not destroy more nature, and that we even try to restore it. While mentioning also culture and social aspects, he used words like respectfully and sustainably. The sustainable development definition of the central administration official was the most mechanical of the four. He sees sustainable development to be human activity that does not cause consumption of natural resources or pollution. Development of technology will assist sustainable development.

Differences between public and private sectors became more obvious when the interviewees were asked about the role of sustainable development in their jobs. All the three public sector representatives see it being built-in in the job. Sustainable development is an everyday matter, work aims at reaching ecological sustainability, and strives to act according to its principles. In the private sector, on the other hand, the weight is in serving customers, and if the customer does not specifically ask to take sustainability issues into account, they will not necessarily be acknowledged. The private sector representative feels that she and her colleagues could act more towards sustainable development if they would think about it and emphasize it more. She mentioned that just recently, sustainable development has become a matter that is discussed in larger contexts, however the ways to implement its principles in every task have not been scrutinized.

The central administration official supposed that sustainable development is mentioned in the strategy as an official value of the office, but it is not considered in everyday work because of its built-in nature. Instead, sustainable development has a central role in the operations of the local administration and research institute. The municipality in question takes part in many sustainability projects, for example to cut down greenhouse gas emissions. In addition, sustainability is taken into account in the office culture by avoiding unnecessary coffee making and working towards paperless office. The research institute in question takes part in several international sustainable development related teams. The 17 United Nation's Sustainable Development Goals (UN 2015b) are visible in different

contexts, and because the research institute is a large organization, practical know-how for all of them can be found from the house.

Finally, the interviewees were asked if their attitude and thoughts about sustainable development had changed since their studies. Only the central administration representative told that his attitudes had stayed the same. In his environmental engineering studies sustainable development was mostly interlocked with recycling and material efficiency. The studies and especially demonstrative examples confirmed his thoughts about sustainable development. In his work, the narrow areas of responsibility of the officials restrict realization of sustainable development principles. As an example, he mentioned dredging projects, and after-use of the dredging waste. It depends on the law if the material can be reused somewhere or if it is treated as waste that needs to be handled and transported away. Because officials are only inspecting their own area of responsibility, the overall picture and the most sustainable solution might be impossible to reach.

Similarly, the local administration representative connected sustainable development with recycling in her studies. According to her, sustainable development and its principles were not present in the water supply and sewerage engineering studies. Work has increased her knowledge about sustainable development, and after few years of silence, it has again become a very timely topic. Climate change has been a big driver in the current development.

Instead, the attitudes and thoughts of research institute and private sector representatives have changed since their studies. The interviewee from the research institute does not recall that his studies would have included any sustainable development content. However, he reckons that it is possible that he simply missed noticing the topic because of lack of interest. He thinks that during the years after graduation, both he and the world have developed so that nowadays he completely signs the importance of the concept.

The interviewee working in the private sector was environmentally conscious during her studies. She thinks that is common in that age, and she even chose the field of studies because of that. Interestingly, she says that sustainable development issues were covered in the studies. The local administration and private sector representative had the same major and they were studying partly at the same time. Still their recollections of the study contents differ in terms of sustainable development. The private sector representative recognizes that her attitude and thoughts about sustainable development have somewhat changed since the study years. In the working life there is not much time to think about sustainability. She would anyway like to consider sustainable development principles more in her work, if it would be possible and if people would put their minds to it. She says that the field of water supply and sewerage aims at environmental protection: sewage is treated, and clean drinking water produced. In that way, the bigger principles of sustainable development are fulfilled. However, sustainability is not considered in practice. As an example, she mentioned pipe materials. Durability and price are considered when choosing pipe materials, but nobody thinks about their disposal or after use.

5 Discussion

5.1 Employment situation is good and secure

This study shows that both quantitative and qualitative employment situations are good in the field of water and environmental engineering. The employment rate of the sample was almost hundred percent at the time of the questionnaire, and almost 70% at the time of graduation, which is on line with the prior studies (Piri 2017; Sainio et al. 2017). Only a few have switched the field, thus there is an overall good correspondence of the current job and engineering studies. In general, the Finnish Master's degree graduates mention ability to tell people about their skills as the most important factor and work experience as the second important factor influencing employment (Sainio et al. 2017). However, engineering graduates value their degree and the subject combination in it over work experience. This tells about the high appreciation of engineering degree in the working life.

Most of the questionnaire respondents said that their current job meets the contents of their studies well. The quality of employment criterion in the upcoming funding models for universities and universities of applied sciences in Finland should thus not cause trouble for the field (Ministry of Education and Culture 2017). However, a slight concern are the environmental engineering majors, whose match with the current job was is slightly lower. The environmental engineering studies were Master's level studies, thus the students entering the program had already a Bachelor's degree, in most cases from universities of applied sciences. It is possible that the contents of their current job meets the contents of their previous, lower degree more than their Master's degree. The central administration interviewee is an example of such a case. He was on study leave from his permanent job that he got with the help of his Bachelor's degree, and the gained Master's degree enabled him to qualify in his office. The Master's studies were not a full match with his job content, but they anyway gave him the needed degree. The students in the new Master's Programme in Water and Environmental Engineering have also various backgrounds, probably even more so than the former environmental engineering majors. What this means for the quality of employment remains to be seen.

The water and environmental engineers have stable and long contracts. Half of the questionnaire respondents had been working for the same employer during their whole career after graduation, and almost one third even in the same duties. This is rare during the times when temporary jobs and their consequences are causing concern (Dawson et al. 2017). According to Eurostat, almost 16% of the employees in Finland had a temporary contract in 2016 (Eurostat 2017). Job security is thus high in the field of water and environmental engineering. However, years spent in the same duties may have also downsides: half of the engineers are working in the expert, planner and project engineer level duties still 10 years after graduation. There are several explanations for the observed slow career development. Possibly the engineers are satisfied with their jobs and they do not wish to climb up the career ladder. It is also natural that expert level duties are the most numerous in the labor market; everybody cannot become managers.

The private sector is by far the largest employer sector for the water and environmental engineers. It seems that the private sector has increased its role during the recent decade. In an employment surveying made in 2012, 24% of the water engineers who had graduated from Helsinki University of Technology or Aalto University since the year 2000 were employed in private design companies (Koskela & Smolander 2012). The survey included

also a category Others in the field (13%), which perhaps contained also some private sector employees. Anyway, the 45% employment rate in the private sector that was found in this study is a notable increase. This change became evident also in the interviews. The private sector representative sees that assignments have increased during her career in a large consultancy, and that the role of the company will most likely increase even further in the future. At the same time, the central administration representative has seen the loss of assignments and the following loss of jobs in public sector during his career. He also pointed out that unfortunately the jobs are not automatically transferred into the private sector and some are lost on the way.

5.2 Clear visions help in achieving career goals

The water and environmental engineering graduates are moderately satisfied with the contents of their studies and readiness for working life after graduation. The most satisfied with their engineering education are the ones who had clear career visions at the time of graduation and who have been able to fulfill those visions. Those nine respondents have also very low, almost non-existent unemployment rate. It seems understandable that if their careers have been progressing according to their visions, they are also satisfied with the studies that helped them to fulfill those visions. Social cognitive career theory explains that if their self-efficacy and career expectations have been strong already during studies, this has led to high career interest and clear career goals, which have been worth to aspire (Lent et al. 2002; Lent 2005). However, two of them would not choose the same field again, which is baffling. On the other hand, their high self-efficacy can be seen an insurance to succeed also in other fields.

The most common reason for dissatisfaction over career choice is realizing how restricted the field and its work prospects are. In the situations where the career prospects are less satisfactory, water and environmental engineers have been forced to adjust to the work environment and accept a job that does not meet the contents of the career expectations (Theory of Work Adjustment: Dawis 2002; 2005; Dawis & Lofquist 1984). They might have even needed to settle for a job that is not a good match with their vocational interests, which can lead to dissatisfaction and instability (Holland's Theory of Vocational Personalities in Work Environment: Holland 1985; 1997). One respondent who is not satisfied with the career choice would make a better decision now, which reflects development of vocational maturity and self-concept (Self-concept Theory of Career Development: Super 1969; 1980; 1990). The ideal job might be very different as a young student than over a decade later because vocational maturity develops at different rate in different individuals, and because the professional roles might end up in conflicts with private roles, such as parenting.

Some respondents have changed the field, possibly because of external realities and constrains, which means that they have been forced to make compromises during their career development (Gottfredson's Theory of Circumscription and Compromise: Gottfredson 1981; 1996; 2002; 2005). If the outcome expectations and career goals are not met, and if the work environment is unsupportive for example because of non-permanent work contracts or non-existent career progress opportunities, the person's self-efficacy might suffer (Social Cognitive Career Theory: Lent et al. 2002; Lent 2005). This can have negative effect on career goals. Similarly, low self-efficacy already at the beginning of the career can hamper formation of expectations and goals. This could be the case with graduates who do not feel ready for working life after studies. Supportive experiences in working life may enhance their self-efficacy and clear up career expectations and goals. However, it is also possible

that even working life does not clarify career goals, which in the long run can lead to dissatisfaction, and field change. Thus, the respondents who have not had career clear career goals at the time graduation or the ones whose careers have been formed along with opportunities might also include graduates who do not have career goals because of low self-efficacy.

The results that the water and environmental engineering graduates are moderately satisfied with the contents of their studies and readiness for working life after graduation is in line with a career study that was made for engineers who had graduated from Aalto University five years earlier in 2011 (Sainio et al. 2017). For the Civil and Environmental Engineering degree program, the average satisfaction is even a bit higher than for the other programs in the School of Engineering. Employers value the engineering degree highly, there are no difficulties finding interesting jobs that match the degree and the studies are giving wide-ranging know-how. However, the respondents of the career study also criticize the somewhat low quality of the education (Sainio et al. 2017). In this study the critique is variable and mild; however, a few respondents mention the lack of basic working life skills and also inadequate IT-skills in the education.

Majority of the respondents say that the central skills and knowledge, roles and attitudes needed in the working life began to form already during the studies. The results are somewhat conflicting since in the open answers they anyway highlight working life in forming the know-how. The four interviewees clarify the matter by saying that basic knowledge of variety of fields is important to learn during studies, while job specific know-how needs to be gained at work. Takala (2013) states that Finnish water supply and sanitation service experts will acquire the job-specific skills and knowledge by learning at work. Thus, the role of education is to provide the basis to build on those competencies, and to promote life-long learning, critical thinking and open communication (Takala 2013). Wide knowledge base can also help to generate, recognize, and incorporate possibilities that can lead to dream jobs (Mitchell et al. 1999).

5.3 Careers are most often formed along with opportunities

Overwhelming majority of the water and environmental engineers tell that their career has been formed along with opportunities. This group also includes the ones who have progressed the furthest on their careers. Thus, clear career plans do not seem to speed up the career path even though they might protect from unemployment. Planned Happenstance Theory encourages people to be open-minded towards chance events in their career, because as a result, they may not end up where they requested but instead where they wanted to end up (Mitchell et al. 1999). The majority of the questionnaire respondents have utilized at least some chance events if their careers have been formed along with opportunities. However, Planned Happenstance does not mean that one should just wait passively for the chance events but to actively generate and look for them, and also to take risks in pursuing them. The questionnaire data shows that switching jobs may advance the career, which might be explained by the simple fact that hardly anybody starts their career from higher-level positions, yet it can also be interpreted as sign of taking chances when encountering them. The fear of taking risks and settle for the current, possibly somewhat unsatisfying situation is evident in one of the answers where the respondent was saying that he has been avoiding unnecessary risks during his career but that he sometimes thinks that he could have been acting more boldly. On the other hand, that could have risked the safe income.

Choosing the along with opportunities -alternative to describe one's career might also reflect somewhat positive attitude towards the situation. Many of the respondents could have probably picked one of the other alternatives as well. However, the answer alternatives saying that one has changed or been forced to change the career visions since the graduation have a negative, even a disappointing tone in them, whereas the along with opportunities - alternative reflects open-mindedness and flexibility. These are also the skills and competencies which are on demand for the insecure workers in the information age (Savickas et al. 2009).

5.4 Wide array of working life competencies are required

According to this study, task performance as well as contextual and adaptive performance (Sonnentag et al. 2008) are all needed in the working life of early-career water and environmental engineers. Furthermore, all three performance categories are needed in every hierarchical level. In line with previous studies, this study also shows how the importance of production and technical skills decreases and social, management and leadership skills increases from lower level position to higher up in the hierarchy (Russell & Yao 1996; Farr & Brazil 2009).

The single most important working life skill for water and environmental engineers is time-management and prioritization. This probably reflects the present hectic work culture more than anything else. Three of the four interviewees said that rush has increased during their career, however none of them mentioned time-management skills as important skill in their work. Possibly it is so obvious skill in every job that it does not come to mind in discussions, but it is chosen when alternatives are given. This was also observed by Passow and Passow (2017) in their recent systematic review analyzing the relative importance of generic engineering competencies. When studies where the respondents got a list of competencies to choose from (quantitative synthesis) were considered, planning and time management was above all other competencies. In their qualitative synthesis (including studies with open-ended questions), time management did not stand out, and the writers ended up including it into two of the 16 important generic engineering competences called Define constraints and Device process (Passow & Passow 2017). Define constraints consists of technical and manufacturing feasibility, such as time, budget, regulations, ethics, as well safety, health, and environmental effects, and societal and communal impacts. Device process includes managing one's own engineering process to accomplish a goal, by choosing what to do and how, how to coordinate competencies, estimate time and cost, plan, set and adjust priorities, schedule and monitor tasks, maintain standards, regulate own work commitments, and meet deadlines and budget.

Takala (2013) interviewed eight Finnish experts in water supply and sanitation and found out that holistic understanding of the water sector, having common sense and the ability to communicate with a variety of stakeholders were the most important competencies for them. In this study, communication and presentation skills were among the most central skills for executives and managers, but systematic, wide-ranging and connective thinking were not prioritized on any work levels. Common sense was not among the given alternatives, nor was it mentioned in open answers. The four interviewees all mentioned people skills, social skills, and especially fluent writing skills as core skills in their jobs. In accordance with the water supply and sanitation experts (Takala 2013), they also emphasize the need to be able to communicate and cooperate with different stakeholders. Engineers might spend more than

half their work day communicating, therefore effective communication through listening, oral, written and graphical means is a core competence for them (Passow & Passow 2017).

Most of the skills that are considered the most essential in the questionnaire responses are generic, skills that could be prioritized basically on any field. They include also skills that can be used to measure contextual performance, such as initiative and self-direction, adaptive performance, such as searching and updating information, and active learning (Sonnentag et al. 2008). These and other prioritized generic skills, such decision making and responsibility, and leadership are actually listed among the soft skills that are considered to be of special importance in the future, i.e. Sustainability Skills, Future Work Skills and 21st Century Skills (CISL 2005; Davies et al. 2011; Partnership for Twenty-First-Century Learning 2016). In addition, Stawiski et al. (2017) observed that integrating leadership development into engineering education might help students to improve also other twenty-first-century skills.

Skills measuring task performance (Sonnentag et al. 2008), the more specific skills or generic engineering skills, such as scientific writing or computational skills are not among the most selected skills. The traditional engineering skill, problem solving, is considered as one of the most important only on expert level. However, that is also the most common level of the respondents. According to Ling (2002), problem solving correlates with job performance. In the quantitative synthesis of Passow and Passow (2017), problem solving is also rated with top importance. In this study, the interviewees mentioned more specific skills when they were asked about the core skills needed in their jobs. They talked about software that they are using daily, modelling skills, geospatial data and information skills and ICT skills. Possibly the large array of skill alternatives and the phrasing of the question, which allowed only five skills to be selected per level, were leading the questionnaire answers to more generic direction. Some of the respondents were even giving feedback by saying that the question was too difficult to answer.

Based on a literary review, Male (2010) suggests that engineering education should focus on teaching generic engineering competencies instead of separate generic competencies and engineering competencies. With generic engineering competencies, Male (2010) means both skills that are generic for all fields including engineering and traditional technical engineering skills. This could advance the otherwise undermined respect of generic competencies in relations to technical competencies and highlight the importance of all these competencies in variety of engineering fields. The results from this study support the suggestion since the water and environmental engineers are prioritizing skills that are describing both task, contextual and adaptive performance (Sonnentag et al. 2008). Passow and Passow (2017) review 27 quantitative and 25 qualitative studies and suggest a list of 16 generic engineering competencies. They are core competencies that are generically important for all fields of engineering, however patterns of importance are based on academic discipline and work environment (Passow & Passow 2017). In addition to Define constraints, Device process, Problem solving and Communicate effectively that were already discussed above, these generic engineering competencies include Interpret data, Apply knowledge, Apply skills, Measure accurately, Coordinate efforts, Take initiative, Gather information, Think creatively, Design solutions, Make decisions, Take responsibility and Expand skills. Thus, problem solving, communication, taking initiative and being self-directional, searching and updating information, and active learning, and decision making and taking responsibility that are core skills for water and environmental engineers in this

study, are also generic engineering competencies around world and in variety of technical disciplines.

Since working life skills and knowledge areas were separated in this study, the more specific competencies are mostly listed as knowledge areas. Therefore, the most important knowledge areas reflect major in engineering studies and also working sector more than the core working life skills. For example, the most important knowledge area for water and environmental engineers, governance and legislation of own field is important especially for engineers working in the public sector, for example the local and central administrative interviewees. The second important knowledge, hydrology and hydraulics is important especially for those who studied water resources and hydraulic engineering as their major.

The more generic knowledge category, Challenges is not considered to be among the top priorities. The category includes a more general challenge Global Sustainable Development Challenges as well as five of the nine Planetary boundaries (Rockström et al. 2009; Steffen et al. 2015). When leaving out the Challenges from the top priority knowledge areas for water and environmental engineers, the questionnaire respondents are showing that they are clearly focusing on solving problems possibly with pre-determined solutions, without pondering too much about the origins of those problems, and possible alternative ways to approach the issues. The respondents working in universities prioritize climate change knowledge more than engineers employed in other sectors, which reflects its role in research. This finding is supported by the interview of the research institute representative, who names climate change to be one of the core knowledge areas in his work. The local administration representative is, nevertheless the one, who had seen the largest effect of climate change in her practical work. Sustainable development has become a timely topic at her work place just recently, and climate change been a big driver in the development. She predicts that the role of climate change in her work will increase further in the coming years.

5.5 Incorporation of sustainable development into the engineering education

This study explores also the role of sustainable development in the water and environmental engineering field. Exactly half of the questionnaire respondents have a positive or somewhat positive opinion about sustainable development being one of the core themes in the new Master's Programme in Water and Environmental Engineering. The justifications for the opinions reflect the hopes and worries that have come up also in previous studies (e.g., Brown et al. 2014; Takala & Korhonen-Yrjänheikki 2013). The most positive opinions highlight all-embracing nature of the concept and point out that sustainable development principles should be taken into account in all actions. The negative opinions have partly the same arguments: interdisciplinary, all-embracing themes do not belong to engineering because they might take the focus away from traditional engineering. Brown et al. (2014) identify three persona types regarding to the beliefs and the actual practice of integration and incorporation of sustainability into their teaching among engineering educators. One of the persona types expresses high level of dogmatism, which is reflected in relative closed belief system that actively prevents the person from accepting new and novel ideas (Brown et al. 2014). Similar perceptions were expressed by some of the Finnish engineering teachers that were interviewed by Takala and Korhonen-Yrjänheikki (2013). They had concerns that incorporating sustainable development into engineering education demands also for understanding the wider concept of engineering and further integrating systemic thinking into the education. This could endanger specialization, if the time would be taken away from

teaching expertise in technical knowledge and skills. Most of the interviewed teachers anyway thought that it is essential and possible to cover both wider contexts and specific technical competencies (Takala & Korhonen-Yrjänheikki 2013).

Because of its ambiguous nature, sustainable development concept challenges engineers and engineering education, which are accustomed to deal with absolute facts (Takala & Korhonen-Yrjänheikki 2013 and references therein). This is also evident in this study. Some of the questionnaire respondents who have slightly positive or slightly negative opinions about the sustainable development theme in the Master's program complain about its vague definition. In addition, one of the interviewees feels that the vagueness of the definition is hampering the person's ability to describe its role at the organization level. The interviewees are all emphasizing the in-build nature of sustainability in their field; that is the aim of the whole work. This is of course positive; however, it can also lead to dismissal of the development part. Anyway, all the interviewees can also pinpoint the strengths and the places for improvement in terms of sustainability in their jobs. With this, they also show understanding of the concept and that they are able to discuss about its role either at the level of their job or at the level of the organization. One of the interviewees and also some questionnaire respondents express quite mechanistic views over sustainability by suggesting technological advancements to be the solution for the problem. Such mechanistic and rationalistic approaches might undermine the complexity and dynamic nature of sustainable development (Takala 2017). Technofix solutions to social problems do not really identify what may be the more pressing problem underneath (Pritchard & Baillie 2006).

5.6 Water and environmental engineers developing a sustainable society

It is obvious that notable proportion of the engineers working in the field of water and environmental engineering have deficient capacity to connect their own tasks with sustainable development. One third of the questionnaire respondents say that their former or current job is not connected to sustainable development. These include people who are currently working in such fields as, for example, waste management, climate change adaptation, or as environmental managers in companies. Majority of the respondents are moderately satisfied with the sustainable development content of their studies and the ones whose current or former job has a connection to it, are slightly more satisfied. This result cannot be held informative if some of the respondents do not understand the concept. However, the interviews are giving some support for these findings. Of the questionnaire respondents, environmental engineering majors are slightly more satisfied and water supply and sewerage engineering majors slightly less satisfied than the rest with the sustainability contents of their studies. The interviewees are connecting sustainability content of their studies with environmental engineering and recycling, whereas they are complaining the complete lack of sustainability issues in water supply and sewerage engineering studies. However, the interviews also indicate that attitudes towards sustainable development and environmental issues in general may have influenced perceptions over study contents; one does not pay attention to those topics that are not interesting and absorbs effectively the fascinating information.

Possibility of water and environmental engineers to influence over sustainability methods and culture of their organizations seems limited. Low rank in the hierarchy, prioritization of economy in the decision making or narrow areas of responsibility may very well restrict the power. However, many of the respondents as well as the interviewees anyway claim to have

the will and the know-how to do more. The current organizations of the four interviewees all mention promotion of sustainable development as their value or as part of their strategy. Thus, in those workplaces applying sustainable development principles at every day work should not only be possible but even desirable. The potential to do more has come up also in earlier studies (Takala & Korhonen-Yrjänheikki 2013). Perhaps the "do as your told" attitude and certain level of dogmatism is obstructing translation of the know-how to everyday life. Finnish engineers have been described as invisible because of the passive role that they have adopted in the society (Michelsen 1999). Problem solving is considered to be one of the greatest strengths of Finnish engineers (Takala & Korhonen-Yrjänheikki 2013). Nonetheless, the future focus should shift from finding single solutions to defining and understanding complex transdisciplinary problems, and therefore being also more visible in the society (Pritchard & Baillie 2006; Takala & Korhonen-Yrjänheikki 2013).

Although the private sector interviewee thinks that sustainable development could be taken into account more in every day work, it is positive that vast majority of the water and environmental engineers working in the private sector consider their work to be connected with sustainable development. This raises expectations especially since its role as the biggest employer of the field will most likely increase further in the future. On the other hand, it may also increase the responsibility of the engineer to implement sustainable development in every day work, if the customer does not specifically demand it, and assuming that the private employer provides the framework for it.

Water supply and sewerage / waste management companies have space for improvement. Majority of the respondents working in this sector are employed by water supply and sewerage companies. Part of the lower connectivity to sustainable development in this sector might thus be due to the lack of sustainability education in the water supply and sewerage engineering studies in the 2000s. On the other hand, majority of the engineers working in the sector are more recently graduated, water and environmental engineering majors. Perhaps the lack of sustainable development connection also reflects the special nature of the water supply and sewerage field, where engineering and natural sciences based core expertise is very much emphasized (Heinonen & Takala 2011). In addition, the connection might be obscured in areas like Finland, where clean drinking water and waste water treatment are taken for granted (Takala 2017).

5.7 Validity and reliability of the results

The results gained from this case study can be held as valid and reliable. Although this study considered only early-career engineers who have graduated from Aalto University or from its predecessor, the results are applicable also on graduates from other universities in Finland. In addition, the found core working life skills are so generic that they most likely reflect the situation also in other engineering fields, and even outside engineering. The 50% response rate to the questionnaire is above the average survey response rates nowadays (Baruch & Holtom 2008). The respondents also represent the alumni group well in terms of their major and gender, which ensures the internal validity of the sample. There was plenty of time to respond, and the nonrespondents also received two reminders. Furthermore, good survey practices were followed (Baruch & Holtom 2008). Most of the questions were multiple choice questions, almost all of them also included space for explanations, clarifications and own choices. The respondents were also provided a chance to give feedback. The importance of the questionnaire data was highlighted, and its purposes of use were listed in the cover letter. The respondents were given a chance to receive a report of

the results, which was sent approximately half a year after the questionnaire was closed. According to the given feedback, this kind of surveys are considered to be important, albeit the respondents did not define the beneficiaries. Some also criticized the length of the survey, and especially the questions regarding the working life skills and knowledge were viewed as difficult to answer. Slightly different design of those questions could have resulted in even higher response rate.

6 Conclusions

This thesis study observes career development, core working life competencies, and the role of sustainable development in the early careers of water and environmental engineers at Aalto University and its predecessor, Helsinki University of Technology. The data was collected using an online questionnaire that was sent to engineers who have graduated during the past ten years (2007-2016) and complemented with four semi-structured theme interviews. Based on this data set, four core conclusions can be made – corresponding to the research questions presented in Chapter 1.

Water and environmental engineers in Finland have been distributed widely in the society, their expertise is required in several sectors and in various duties. The engineering degree has kept its high value in the labor market. Unlike many other fields nowadays, water and environmental engineers have quite safe employment situation; unemployment rate is low and contracts are long-term. However, the results show that switching jobs may advance the career. The majority of the questionnaire respondents have not had clear career plans and their careers have been formed along with opportunities.

The traditional engineering skills, such as problem solving are still needed, however like any other field also engineers are forced to enlarge their toolbox. This study shows that the skills, that are also called future working life skills, the sustainable development skills or 21st century skills, are already now core competencies in the field and their importance will probably increase in the future. Modern working life with complex tasks and new challenges, such as social media, demand time-management and prioritization skills from everybody. Today, general engineering skills include also people skills, taking initiative and being self-directional, being up-to-date by actively searching for information and learning, and being able to make decision and taking responsibility.

Sustainable development has a central role in the field of water and environmental engineering. Yet, there are several early-career engineers working in the field who have deficient knowledge of sustainable development, and who are therefore incapable of connecting the principles of sustainable development into their own expertise. Interestingly, the wide-ranging nature of the concept and vagueness of its definition can be seen both as an asset and as a hindrance. Those who present the fiercest criticism towards sustainable development see it as a nice theory with little application to practical work, while others see it being built-in in the field and as the only way to ensure survival of the humankind. Integrating sustainable development into water and environmental engineering requires understanding of wider concept than traditional solving of predetermined problems, as well as using systemic thinking. Therefore, also engineering education needs to cover both wider contexts and specific technical competencies. The new Master's Programme in Water and Environmental Engineering in Aalto University is thus very up-to-date. According to this study, this development is necessary to be able to fulfill the needs of the working life.

Even though developing sustainable world is mentioned in strategies or emphasized in visions and values of organizations, sustainable development is hardly yet seen in everyday tasks. Water and environmental engineers seem to have more sustainable development related knowledge and skills than what they are able to capitalize on their jobs. Furthermore, this hidden capital is distributed widely in the society. As the private sector is increasing its share in the field, the main power over building a more sustainable society lies there. The

water and environmental engineers with their wide set of competencies could take a larger role in building it. Game changers are wanted!

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Aalto-yliopisto

Työelämä- ja urakysely Aalto-yliopiston vesi- ja ympäristötekniikan alumneille

1. Työllistyminen valmistumisen jälkeen

Pyydämme sinua palauttamaan mieleesi diplomi-insinööriksi valmistumishetken. Valitse yksi vastausvaihtoehto, joka kuvaa silloista tilannettasi parhaiten.

1.1 Valmistumisvuosi. *

2007

1.2 Kuinka monta vuotta opiskelualaan liittyvää työkokemusta sinulla oli ennen valmistumista? *

0

1.3 Kuvaile tilannettasi valmistumishetkellä. *

- ○ Minulla oli työsopimus
- ○ Työskentelin yrittäjänä
- ○ Etsin töitä
- ○ Tiesin mistä saisin töitä
- ◉ Jatkoin opintojani kokopäiväisenä tohtorikoulutettavana (myös apurahalla väitöskirjaa valmistelevat)
- ○ Jokin muu, mikä?

1.4 Sinulla oli valmistumishetkellä työsopimus tai yritys. Olitko kokoaikatyössä / yrittäjä jo opiskeluaikana? *

- ◉ En
- ○ Kyllä, kuinka monta kuukautta?

1.5 Kuinka monta kuukautta kului valmistumisen ja työllistymisen välillä? *

En ole vielä löytänyt töitä

1.6 Miten sait ensimmäisen valmistumisen jälkeisen työpaikkasi? *

- ◉ Tein diplomityön samaan paikkaan
- ○ Yliopiston tai muiden rekrytointipalvelujen, -tapahtumien & –ohjelmien kautta
- ○ Henkilökohtaisten kontaktien ja verkostojen avulla
- ○ Minuun otettiin yhteyttä
- ○ Lähettämällä avoimia hakemuksia ja ottamalla yhteyttä
- ○ Vastasin avoimeen työpaikkailmoitukseen
- ○ Perustin oman yrityksen
- ○ Muulla tavoin, miten?

1.7 Oliko diplomityölläsi merkitystä ensimmäisen valmistumisen jälkeisen työsi saantiin? *

- ○ Ei
- ◉ Kyllä.
  Millainen? jatkoin samasta aiheesta

1.8 Millaisia taitoja ja tietoja oli vaatimuksena ensimmäiseen valmistumisen jälkeiseen työhösi? *

1.9 Millä yhteiskuntaelämän sektorilla valmistumisen jälkeinen ensimmäinen työorganisaatiosi toimi? *

- ○ Yhdistys / kolmas sektori
- ○ Keskushallinto
- ○ Paikallishallinto
- ○ Tutkimuslaitos
- ◉ Yliopisto
- ○ Yksityinen sektori

1.10 Mikä oli ensimmäisen valmistumisen jälkeisen työsi taso? *

- ○ Harjoittelija / Assistentti / Avustaja
- ◉ Asiantuntija / Suunnittelija / Projekti-insinööri / Tohtorikoulutettava
- ○ Tiimipäällikkö / Projektipäällikkö / Tutkija
- ○ Yksikön päällikkö / Projektin johtaja / Erikoisasiantuntija
- ○ Johtaja
- ○ Pääjohtaja / Toimitusjohtaja / Omistaja

1.11 Asteikolla 1–5, kuinka hyvin tai huonosti ensimmäinen valmistumisen jälkeinen työsi vastasi sisällöltään opintojasi? *

1 = Oikein huonosti / ei ollenkaan. 5 = Oikein hyvin. Voit halutessasi perustella vastaustasi oheiseen tekstikenttään.

Oikein huonosti / ei ollenkaan	Huonosti	Kohtalaisesti	Hyvin	Oikein hyvin
1 ○	○	○	○	○ 5

1.12 Kuinka hyvin ensimmäisen valmistumisen jälkeisen työsi taso vastasi opinnoista saatua osaamisen tasoa? *

Voit halutessasi tarkentaa vastaustasi oheiseen tekstikenttään.

- ○ Selvästi alle koulutustason
- ○ Hieman alle koulutustason
- ◉ Vastaa koulutustasoa
- ○ Hieman yli koulutustason
- ○ Selvästi yli koulutustason
- ○ En voi vastata

2. Työura ja tämänhetkinen työtilanne

Siirrytään nyt miettimään aikaa valmistumisen ja tämän hetken välillä, sekä tämänhetkistä työtilannetta. Valitse se vaihtoehto, joka parhaiten kuvaa tilannettasi.

2.1 Kuinka monta eri työnantajaa sinulla on ollut valmistumisesi jälkeen? *

1

2.2 Kuinka monta erillistä työtehtävää sinulla on ollut valmistumisesi jälkeen? *

Laske mukaan myös siirtyminen toisiin tehtäviin samalla työnantajalla.

1

2.3 Millä sektoreilla olet työskennellyt valmistumisesi jälkeen? *

Voit valita niin monta vaihtoehtoa kuin on tarpeen.

- [x] Yhdistys / kolmas sektori
- [x] Keskushallinto
- [x] Paikallishallinto
- [x] Tutkimuslaitos
- [x] Yliopisto
- [x] Yksityinen sektori
- [x] Ei mikään näistä

2.4 Kuinka monta vuotta olet valmistumisesi jälkeen työskennellyt listattujen tasojen tehtävissä?

Merkitse puolen vuoden tarkkuudella kokemuksesi kyseisen tason työtehtävistä.

Harjoittelija / Assistentti / Avustaja *

1

Asiantuntija / Suunnittelija / Projekti-insinööri / Tohtorikoulutettava *

1

Tiimipäällikkö / Projektipäällikkö / Tutkija *

1

Yksikön päällikkö / Projektin johtaja / Erikoisasiantuntija *

1

Johtaja *

1

Pääjohtaja / Toimitusjohtaja / Omistaja *

1

Voit halutessasi perustella vastauksiasi oheiseen tekstikenttään.

2.5 Kuvaile tämänhetkistä työtilannettasi. *

- ○ Minulla on työsopimus
- ○ Työskentelen yrittäjänä
- ○ Etsin töitä / olen työvoimakoulutuksessa / olen TE-keskuksen kautta työharjoittelussa
- ○ Tiedän mistä saisin töitä
- ○ Työskentelen kokoaikaisesti apurahatutkijana
- ○ Työskentelen kokoaikaisesti tohtorikoulutettavana (myös apurahalla väitöskirjaa valmistelevat)
- ◉ Jokin muu, mikä?

2.6 Mikä on tämänhetkisen työsi taso? *

- Harjoittelija / Assistentti / Avustaja
- Asiantuntija / Suunnittelija / Projekti-insinööri / Tohtorikoulutettava
- Tiimipäällikkö / Projektipäällikkö / Tutkija
- Yksikön päällikkö / Projektin johtaja / Erikoisasiantuntija
- Johtaja
- Pääjohtaja / Toimitusjohtaja / Omistaja
- (•) Jokin muu, mikä?

2.7 Millä yhteiskuntaelämän sektorilla nykyinen työorganisaatiosi toimii? *

- Yhdistys / kolmas sektori
- Keskushallinto
- Paikallishallinto
- Tutkimuslaitos
- Yliopisto
- Yksityinen sektori
- (•) Jokin muu, mikä? [ ]

2.8 Asteikolla 1–5, kuinka hyvin tai huonosti tämänhetkisen työsi sisältö vastaa opintojasi? *

1 = Oikein huonosti / ei ollenkaan. 5 = Oikein hyvin. Voit halutessasi perustella vastaustasi oheiseen tekstikenttään.

Oikein huonosti / ei ollenkaan	Huonosti	Kohtalaisesti	Hyvin	Oikein hyvin
1 ○	○	○	○	○ 5

[ ]

2.9 Kuinka monta vuotta olet yhteensä ollut työttömänä valmistumisesi jälkeen? *

Vastaa puolen vuoden tarkkuudella.

[0 ▾]

2.10 Kuinka monta kertaa olet ollut työttömänä valmistumisesi jälkeen? *

[0 ▾]

2.11 Mikä seuraavista väittämistä kuvaa parhaiten työuraasi? *

- Minulla oli valmistuessani selvä kuva uratavoitteistani, ja se on säilynyt muuttumattomana.
- Minulla oli valmistuessani selvä kuva uratavoitteistani, mutta se on sen jälkeen muuttunut.
- Urapolkuni on muodostunut työmahdollisuuksien mukana.
- Minulla oli valmistuessani selkeät uratavoitteet, mutta niitä on ollut pakko muuttaa.
- (•) Minulla oli valmistuessani heikko kuva uratavoitteistani, mutta ne ovat sittemmin vahvistuneet.
- Minulla oli valmistuessani jonkinlainen ajatus uratavoitteistani, mutta päädyin seuraamaan toista urapolkua.
- Jokin muu, mikä? [ ]

2.12 Asteikolla 1-5, kuinka todennäköisesti valitsisit saman alan jos olisit nyt lähdössä opiskelemaan? *

1 = Hyvin epätodennäköisesti. 5 = Hyvin todennäköisesti. Voit halutessasi perustella vastaustasi oheiseen tekstikenttään.

Hyvin epätodennäköisesti	Epätodennäköisesti	Mahdollisesti	Todennäköisesti	Hyvin todennäköisesti
1 ○	○	○	○	○ 5

[ ]

3. Työelämässä tarvittavat tiedot ja taidot

Nyt siirrymme kolmanteen osioon, joka käsittelee työelämässä tarvittavia tietoja ja taitoja. Valitse kysymyksiin vain yksi vastausvaihtoehto ellei toisin mainita.

3.1 Asteikolla 1-5, kuinka hyvin tai huonosti maisteriopintosi valmistivat sinua työelämään? *

1 = Oikein huonosti / ei ollenkaan. 5 = Oikein hyvin. Voit halutessasi perustella vastaustasi oheiseen tekstikenttään.

	Oikein huonosti / ei ollenkaan	Huonosti	Kohtalaisesti	Hyvin	Oikein hyvin	
1	○	○	○	○	○	5

3.2 Totta vai ei? Työelämässä tarvittavat keskeiset tiedot ja taidot (erityistaidot, osaamisalueet, asenne, roolit) alkoivat muodostua jo opiskeluaikana. *

○ Ehdottomasti ei totta ◉ Ei totta ○ Ehkä totta, ehkä ei ○ Totta ○ Ehdottomasti totta ○ En pysty vastaamaan

3.3 Mitkä ovat kokemuksesi perusteella 5 tärkeintä taitoa eri työtasojen tehtävissä?

Täytä vain sarakkeet joiden tasoilla olet työskennellyt. Valitse 5 tärkeintä taitoa kullekin tasolle.

	Harjoittelija / Assistentti / Avustaja	Asiantuntija / Suunnittelija / Projekti-insinööri / Tohtorikoulutettava	Tiimipäällikkö / Projektipäällikkö / Tutkija	Yksikön päällikkö / Projektin johtaja / Erikoisasiantuntija	Johtaja	Pääjohtaja / Toimitusjohtaja / Omistaja
Ajanhallinta & priorisointi	☐	☐	☐	☐	☐	☐
Analyyttinen & kriittinen ajattelu	☐	☐	☐	☐	☐	☐
Eettinen & arvopohjainen ajattelu	☐	☐	☐	☐	☐	☐
Ennakointikyky & tulevaisuusorientoituneisuus	☐	☐	☐	☐	☐	☐
Esiintymistaidot & kommunikointikyky	☐	☐	☐	☐	☐	☐
Itseohjautuvuus & oma-aloitteisuus	☐	☐	☐	☐	☐	☐
Joustavuus & luovuus	☐	☐	☐	☐	☐	☐
Johtajuus	☐	☐	☐	☐	☐	☐
Järjestely- & koordinointikyvyt	☐	☐	☐	☐	☐	☐
Kyky tehdä päätöksiä & ottaa vastuuta	☐	☐	☐	☐	☐	☐
Kyky tehdä & toteuttaa muutoksia	☐	☐	☐	☐	☐	☐
Ryhmätyötaidot	☐	☐	☐	☐	☐	☐
Laskentataidot	☐	☐	☐	☐	☐	☐
Neuvottelutaidot	☐	☐	☐	☐	☐	☐
Ongelmanratkaisu	☐	☐	☐	☐	☐	☐
Opetus- & ohjaustaidot	☐	☐	☐	☐	☐	☐
Sosiaaliset taidot	☐	☐	☐	☐	☐	☐
Systeeminen, laaja-alainen & kokonaisuuksia yhdistävä ajattelu	☐	☐	☐	☐	☐	☐
Teorioiden ymmärrys & niiden soveltaminen	☐	☐	☐	☐	☐	☐
Tiedonhaku, kehityksen seuraaminen & uuden oppiminen	☐	☐	☐	☐	☐	☐

Tieteidenvälisyys / moniammatillisissa ympäristöissä toimiminen	☐	☐	☐	☐	☐	☐
Jokin muu, mikä?	☐	☐	☐	☐	☐	☐
Jokin muu, mikä?	☐	☐	☐	☐	☐	☐

Voit halutessasi perustella vastauksiasi oheiseen tekstikenttään.

3.4 Mitkä ovat mielestäsi / kokemuksestasi 5 tärkeintä osaamisaluetta, joita olet tarvinnut eri työtasoilla?

Täytä vain sarakkeet joiden tasoilla olet työskennellyt. Valitse 5 tärkeintä osaamisaluetta niistä jokaiselle.

	Harjoittelija / Assistentti / Avustaja	Asiantuntija / Suunnittelija / Projekti-insinööri / Tohtorikoulutettava	Tiimipäällikkö / Projektipäällikkö / Tutkija	Yksikön päällikkö / Projektin johtaja / Erikoisasiantuntija	Johtaja	Pääjohtaja / Toimitusjohtaja / Omistaja
Elinkiertoajattelu	☐	☐	☐	☐	☐	☐
Globaalit kestävän kehityksen haasteet	☐	☐	☐	☐	☐	☐
Hydrologia & hydrauliikka	☐	☐	☐	☐	☐	☐
Ilmastonmuutos	☐	☐	☐	☐	☐	☐
Johtaminen	☐	☐	☐	☐	☐	☐
Kiertotalous & jätehuolto	☐	☐	☐	☐	☐	☐
Liiketoiminnan & talouden perusteet	☐	☐	☐	☐	☐	☐
Luonnon monimuotoisuuden merkityksen merkityksen ymmärtäminen	☐	☐	☐	☐	☐	☐
Maankäytön muutokset	☐	☐	☐	☐	☐	☐
Oman alan lainsäädäntö & hallinto	☐	☐	☐	☐	☐	☐
Oman alan teoriat	☐	☐	☐	☐	☐	☐
Rakennustekniikan käytännön tunteminen	☐	☐	☐	☐	☐	☐
Rehevöityminen & saastuminen	☐	☐	☐	☐	☐	☐
Riskianalyysi	☐	☐	☐	☐	☐	☐
Sosiaalinen vastuu	☐	☐	☐	☐	☐	☐
Typen & fosforin biogeokemiallinen kierto	☐	☐	☐	☐	☐	☐
Vesitekniikan & –huollon käytännön tunteminen	☐	☐	☐	☐	☐	☐
Ympäristötekniikan käytännön tunteminen	☐	☐	☐	☐	☐	☐
Yrittäjyys	☐	☐	☐	☐	☐	☐
Jokin muu, mikä?	☐	☐	☐	☐	☐	☐
Jokin muu, mikä?	☐	☐	☐	☐	☐	☐

Voit halutessasi perustella vastauksiasi oheiseen tekstikenttään.

3.5 Uuden maisteriohjelman tavoitteeksi on määritelty kestävän ja toimivan yhteiskunnan varmistaminen, ja kestävä kehitys on täten yksi ohjelmaa läpileikkaavista keskeisistä teemoista. Mitä mieltä olet tällaisesta yläteemasta? Millaisena näet kestävän kehityksen osaamisen roolin vesi- ja ympäristötekniikan alalla?

3.6 Liittyvätkö nykyinen tai aiempi työsi kestävään kehitykseen? *

- ○ Ei
- ◉ Kyllä, miten? kuuluu vastuualueisiin

3.7 Asteikolla 1-5, kuinka hyvin tai huonosti opintosi tarjosivat tietoa siitä miten toimia alalla kestävän kehityksen periaatteiden mukaisesti? *

1 = Oikein huonosti / ei ollenkaan. 5 = Oikein hyvin. Voit halutessasi perustella vastaustasi oheiseen tekstikenttään.

Oikein huonosti / ei ollenkaan	Huonosti	Kohtalaisesti	Hyvin	Oikein hyvin
1 ○	○	○	○	○ 5

3.8 Onko sinulla mahdollisuus vaikuttaa nykyisen organisaatiosi kestävän kehityksen toimintatapoihin ja -kulttuuriin? *

Voit halutessasi perustella vastaustasi oheiseen tekstikenttään.

- ○ Erittäin vähän / olemattomasti
- ○ Vähän
- ◉ Kohtalaisesti
- ○ Paljon
- ○ Erittäin paljon
- ○ En voi vastata

4. Olet jo melkein valmis! Tämä osio on vapaaehtoinen.

Haluatko antaa palautetta?

Tai kommentoida kyselyä? Vai haluatko kertoa vielä jotain, jota emme osanneet kysyä? Sana on vapaa!

ggff

5. Taustatiedot

Aineisto arkistoidaan ilman henkilötietoja, eikä henkilötietojasi yhdistetä vastauksiisi.

Etunimi.

Sukunimi.

Syntymävuosi. *

Sukupuoli. *

- Mies
- Nainen
- Muu

Kansallisuus.

Kotipaikka.

Diplomi-insinööriopintojen aloitusvuosi. *

Pääaine. *

- Vesihuolto
- Vesitalous ja -rakennus
- Vesi- ja ympäristötekniikka
- Ympäristötekniikka
- Jokin muu, mikä?

6. Alumni- ja mentoritoiminta

Olemme muodostamassa Vesi- ja ympäristötekniikasta valmistuneiden alumnisähköpostilistaa, jolle lähetämme harkitusti viestejä tutkimukseen ja opetukseemme, sekä yleisesti alaamme liittyen. Haluatko että lisäämme sinut listalle? *

- Kyllä
- Ei

Oletko kiinnostunut osallistumaan Aalto-yliopiston mentorointi-ohjelmaan (https://alumninet.aalto.fi/Palvelut/Mentorointi.aspx), jossa meiltä valmistuneet jo työelämässä olevat henkilöt ohjaavat opiskelijoitamme uraan ja työelämään liittyvissä asioissa? Saammeko lisätä nimesi ja yhteystietosi mentori-listalle? *

- Kyllä
- Ei

Haluatko saada tämän kyselytutkimuksen yhteenvedon sähköpostiisi? *

- (•) Kyllä
- ( ) Ei

Jos vastasit johonkin yllä olevasta kolmesta kysymyksestä 'Kyllä', ilmoita sähköpostiosoitteesi, johon voimme olla yhteydessä.

Suuri kiitos vaivannäöstäsi ja mukavaa kesänjatkoa!

0% valmiina

Kesällä 2017 suoritimme kyselytutkimuksen viimeisen 10 vuoden aikana Aalto-yliopistosta tai sen edeltäjästä Teknillisestä korkeakoulusta vesi- ja ympäristötekniikan aloilta diplomi-insinööreiksi valmistuneille. Kyselyssä kartoitettiin työllistymistä, urakehitystä, opintojen antamia valmiuksia, alan osaamistarpeita, sekä kestävän kehityksen roolia alalla. Kyselyyn vastasi 88 alumnia, ja olit yksi kyselyn vastaajista.

Tämän haastattelun tarkoituksena on syventää kyselytutkimuksen tuloksia. Haastattelu kestää noin tunnin. Tutkimuksella kerättävää tietoa hyödynnetään maisteriohjelman kehittämisessä. Lisäksi haastatteluilla kerättyä aineistoa käytetään keväällä 2018 valmistuvassa diplomityössä.

Aineisto käsitellään luottamuksellisesti. Haastattelu nauhoitetaan ja vastauksia saatetaan käyttää anonyymisti osana tutkimuksiamme ja raportteja.

Taustakysymykset
Tarkoitus: saada tarkempi käsitys työnkuvasta, sekä selvittää onko haastateltavalla DI-tutkinnon lisäksi mahdollisesti työllistymiseen ja uraan vaikuttavaa muuta koulutusta.

- Pääaine
- Valmistumisvuosi
- Mikä on nykyinen työnantajasi?
- Millaisissa tehtävissä työskentelet? Mikä on työnkuvasi? Kuvaile tavanomainen työtehtävä.
- Kuinka kauan olet ollut nykyisessä työssäsi?
- Kuinka kauan olet ollut tällä alalla?
- Onko sinulla jokin muu koulutus DI-tutkinnon lisäksi? Entä oletko tehnyt suunnattua täydentävää koulutusta esim. työnantajan tarjoamana?

Osaamisalueet ja työelämätaidot
Tarkoitus: selvittää vastaajan näkemyksiä työelämätaidoista ja osaamisalueista. Mitä insinööriltä vaaditaan? Mitkä ovat vastaajan painotukset ryhmien välillä? Entä perustelut? Miten näkee oman työnkuvansa?

Seuraavaksi haluaisin kysyä mielipiteitäsi työelämässä tarvittavista tiedoista ja taidoista.

- Mitkä ovat nykyisessä työssäsi tarvitut keskeisimmät tiedot ja taidot? Miksi?
- Miten nämä tarvittavat tiedot ja taidot ovat muuttuneet työurasi varrella?

→ Tarvittiinko aiemmissa työtehtävissäsi erilaisia tietoja ja taitoja? Miksi?

- Millaisia valmiuksia omat opintosi aikoinaan tarjosivat? Mitkä ovat olleet hyödyllisimmät opintojen antamat tiedot ja taidot? Miksi? Entä mitä on jäänyt puuttumaan?

- Millaisia valmiuksia (tietoja ja taitoja) Aallon WAT-ohjelman tulisi sinun mielestäsi tarjota nykyisille opiskelijoille? Miksi? Entä millaisia tietoja ja taitoja olisi hyvä/mahdollista oppia vasta työelämässä? Miksi?

Alan kehitys
Tarkoitus: selvittää vastaajan näkemyksiä alastaan ja sen kehityksestä. Miten ala on muuttunut sillä aikaa kun olet sillä työskennellyt?

- Miten määrittelisit oman alasi? Mikä on alasi?

- Onko ala muuttunut sinä aikana kun olet alalla työskennellyt? Miten?

- Tuntuuko sinusta että alalla työskenteleviin kohdistuneet vaatimukset ovat muuttuneet sinä aikana? Miten?

- Millaisena näet alan tulevaisuuden? Millaisia muutoksia on luvassa esim. seuraavien 10 vuoden aikana?

Kestävän kehityksen rooli
Tarkoitus: Ymmärtää vastaajan suhtautumista kestävän kehityksen periaatteisiin, siihen ymmärtääkö mitä se on, ja miten se liittyy omaan alaan/työhön.

Aalto-yliopiston tavoitteena on saada vastuullisuus ja kestävä kehitys läpileikkaavana teemana osaksi kaikkea opetusta. Kestävä kehitys onkin yksi vesi- ja ympäristötekniikan uuden maisteriohjelman keskeisistä teemoista.

- Miten määrittelisit kestävän kehityksen? Mitä se mielestäsi tarkoittaa?

- Millaisena näet kestävän kehityksen roolin omassa työssäsi?

- Entä omalla työpaikallasi?

- Entä omalla alalla?

- Ovatko omat ajatuksesi kestävästä kehityksestä muuttuneet opiskeluajoista? Koetko, että DI-opintosi vaikuttivat ajatuksiisi ja asennoitumiseesi kestävää kehitystä kohtaan? Jos, niin miten, ja mitkä tekijät vaikuttivat erityisesti?

- Onko työelämä muokannut asennoitumistasi, ja miten? Mitkä tekijät työelämässä ovat erityisesti vaikuttaneet?

Yhteenveto ja lopetus

- Onko sinulla vielä mielessä joku kysymys, joka olisi pitänyt kysyä ja/tai johon olisit halunnut vastata?

- Entä onko sinulla kysyttävää minulle?

Kiitos paljon haastattelusta! Tässä tuli esiin monia hyödyllisiä asioita.